FINAL

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY WORK PLAN FOR SITES 6, 9, 48 AND 69 MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0024

Prepared For:

NAVAL FACILITIES
ENGINEERING COMMAND
ATLANTIC DIVISION
Norfolk, Virginia

Under:

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Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
bls	below land surface
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEJ	Camp Lejeune
CSM	Chemical Surety Compound
1,2-DCE	1,2-dichloroethene or 1,2-dichloroethylene
DOD	Department of the Defense
DoN	Department of the Navy
EMD	Environmental Management Division (Camp Lejeune)
EPA	United States Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
FFA	Federal Facilities Agreement
ft	feet
ft/ft	foot per foot
GAC	granular activated carbon
gpm	gallons per minute
GRI	Gas Research Industry
HI	hazard index
HPIA	Hadnot Point Industrial Area
IAS	Initial Assessment Study
IRP	Installation Restoration Program
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
MDL	method detection limit
mg/l	milligram per liter
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
N.C. DEHNR	North Carolina Department of Environment, Health, and Natural Resources
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance

PAH	polynuclear aromatic hydrocarbon
PCB	Polychlorinated Biphenyls
POTW	publicly owned treatment works
ppb	parts per billion
ppm	parts per million
PRAP	Proposed Remedial Action Plan
RA	risk assessment
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SMCL	Secondary Maximum Contaminant Level
STP	sewage treatment plant
TCE	trichloroethene or trichloroethylene
TCLP	toxicity characteristic leaching procedure
µg/L	micrograms per liter
VOC	volatile organic compound

1.0 INTRODUCTION

Marine Corps Base (MCB) Camp Lejeune (CLEJ) was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) effective November 4, 1989 (54 Federal Register 41015, October 4, 1989). Subsequent to this listing, the United States Environmental Protection Agency (EPA) Region IV, the North Carolina Department of Environment, Health and Natural Resources (DEHNR), and the United States Department of the Navy (DoN) entered into a Federal Facilities Agreement (FFA) for MCB Camp Lejeune (CLEJ). The primary purpose of the FFA was to ensure that environmental impacts associated with past and present activities at the MCB are thoroughly investigated and appropriate CERCLA response/RCRA corrective action alternatives are developed and implemented as necessary to protect the public health, welfare and the environment (MCB Camp Lejeune FFA, 1986).

The scope of the FFA included the implementation of a remedial investigation/feasibility study (RI/FS) at 23 sites throughout MCB Camp Lejeune. Remedial investigations will be implemented at these sites to determine fully the nature and extent of the threat to the public health, welfare or the environment caused by the release and threatened release of hazardous substances, pollutants, contaminants or constituents at the site and to establish requirements for the performance of FSs. Feasibility studies will be conducted to identify, evaluate, and select alternatives for the appropriate CERCLA responses to prevent, mitigate, or abate the release or threatened release of hazardous substances, pollutants, contaminants, or constituents at the site in accordance with CERCLA/SARA and applicable State law (FFA, 1989). This RI/FS Work Plan addresses four of the 23 sites: Site 6 (Storage Lots 201 and 203), Site 9 (Fire Fighting Training Pit) Site 48 (MCAS Mercury Dump), and Site 69 (Rifle Range Chemical Dump).

1.1 Objective of RI/FS Work Plan

The objective of this RI/FS Work Plan is to identify the tasks required to implement an RI/FS for Sites 6, 9, 48, and 69 at MCB Camp Lejeune. The various studies or investigations required to collect appropriate data are also described in this Work Plan. In addition, the Work Plan documents the scope and objectives of the RI/FS activities. It serves as a tool for assigning responsibilities and establishing the project schedule and cost. The preparation and contents of the RI/FS Work Plan is based on the scoping process, which is described below.

1.2 RI/FS Scoping

Scoping is the initial planning stage of the RI/FS and of site remediation. The result or outcome of the scoping process is documented in the RI/FS Work Plan. Scoping begins once the background information is reviewed and evaluated and consists of the following activities:

- Preliminarily assessing human health and environmental risks, based on existing information.
- Identifying potential interim actions to mitigate potential threats to the public health and the environment.
- Identifying potential contaminant migration pathways.
- Identifying contaminants of concern.
- Identifying Federal and State Applicable or Relevant and Appropriate Requirements (ARARs).
- Identifying potential technologies/alternatives for mitigating site problems.
- Determining the type, amount, and data quality objectives (DQOs) needed to assess human health and environmental risks, and to effectively evaluate feasible technologies/alternatives.
- Identifying the sampling strategies for the collection of data.
- Defining the optimum sequence of site activities.

The background information included a number of existing environmental assessment reports, which are identified in Section 8 (References) and information collected by conducting site visits of all four sites.

As part of the scoping process, project meetings were conducted with the Atlantic Division, Naval Facilities Engineering Command (LANTDIV) to discuss the proposed RI/FS scope of work for each site, and to obtain technical and administrative input from LANTDIV.

1.3 RI/FS Work Plan Format

The following elements are presented in the remaining sections of this Work Plan.

Section 2 - Site Background and Setting
Section 3 - Evaluation of Existing Information
Section 4 - RI/FS Objectives
Section 5 - RI/FS Tasks
Section 6 - Project Staffing
Section 7 - Project Schedule
Section 8 - References

Section 2 includes information regarding the location and setting of each site, along with a summary of what studies were conducted to date at each site and their respective findings. The purpose of this section is to define the physical and known environmental characteristics of each site.

Section 3 documents the evaluation of background information. This section focuses on identifying potential or confirmed contaminant migration pathways, identifying potential (or known) impacts to the public health and environment, listing Federal or State ARARs, and evaluating potential remedial technologies/alternatives for mitigating site problems. The purpose of this evaluation is to define site-specific RI/FS objectives. Data or information deemed necessary to identify migration pathways, assess environmental and human health risks, or evaluate the feasibility of remedial actions are presented in this section.

Section 4 presents the RI/FS objectives for each site. Data or information required to meet the objectives are subsequently identified and documented in this section. This data may consist of chemical analyses, hydrogeologic information, or engineering analyses. The collection methods for obtaining this information are also identified and described in general terms (more detailed descriptions of the field investigations are documented in the Sampling and Analysis Plan). This section provides the rationale for development of this Work Plan.

Section 5 identifies and describes the tasks and field investigations that will need to be implemented to complete the RI/FS at each site. These tasks generally follow the description of tasks identified in EPA's RI/FS Guidance Document (OSWER Directive 9355.3-01).

Section 6 discusses project staffing for implementing RI/FSs at the four sites. The RI/FS schedule is provided in Section 7 and references to this report are provided in Section 8.

2.0 BACKGROUND AND SETTING

The purpose of this section is to summarize and evaluate existing information pertaining to MCB Camp Lejeune, Site 6, Site 9, Site 48, and Site 69. The analysis of existing information will serve to provide an understanding of the nature and extent of contamination in order to aid in the design of RI tasks. The current understanding of the physical setting of the sites, the history of the sites, and the existing information related to previous environmental investigative activities are described herein.

This section specifically addresses the location and setting of the sites, historical events associated with past usage or disposal activities, topography and surface drainage, regional geology and hydrogeology, site-specific geology and hydrogeology, surface water hydrology, climatology, natural resources and ecological features, and land use.

Additional information can be found in the following documents:

- Initial Assessment Study (IAS) of Marine Corps Base Camp Lejeune, North Carolina (Water and Air Research, 1983)

- Site Assessment Report for Sites 6, 48, and 69, Characterization Study to Determine Existence and Possible Migration of Specific Chemical In Situ, (Environmental Science and Engineering, Inc., 1991)

- Final Site Summary Report, Marine Corps Base, Camp Lejeune (Environmental Science and Engineering, Inc. 1990)

- Hydrogeology of Aquifers in Cretaceous and Younger Rocks in the Vicinity of Onslow and Southern Jones Counties, North Carolina (U.S. Geological Survey, 1990)

- Continuous Seismic Relection Profiling of Hydrogeologic Features Beneath New River, Camp Lejeune, North Carolina (U.S. Geological Survey, 1990)

- Assessment of Hydrologic and Hydrogeologic Data at Camp Lejeune Marine Corps Base, North Carolina (U.S. Geological Survey, 1989)

2.1 Marine Corps Base Camp Lejeune

This section provides an overview of the physical features associated with MCB Camp Lejeune.

2.1.1 Location and Setting

Marine Corps Base Camp Lejeune is located within the coastal plain in Onslow County, North Carolina. The facility covers approximately 170 square miles and is bisected by the New River, which flows in a southeasterly direction and forms a large estuary before entering the Atlantic Ocean.

The eastern border of Camp Lejeune is the Atlantic shoreline. The western and northwestern boundaries are U.S. 17 and State Route 24, respectively. The City of Jacksonville, North Carolina, borders Camp Lejeune to the north. The MCB Camp Lejeune is depicted in Figure 2-1.

2.1.2 History

Construction of MCB Camp Lejeune began in 1941 with the objective of developing the "Worlds Most Complex Amphibious Training Base". Construction of the base started at Hadnot Point, where the major functions of the base are centered. Development at the Camp Lejeune complex is primarily in five geographical locations under the jurisdiction of the Base Command. These areas include Camp Geiger, Montford Point, Courthouse Bay, Mainside, and the Rifle Range Area. Site 6 and 9 are located in the Mainside, and Site 69 is located in the Rifle Range Area. Marine Corps Air Station (MCAS) New River, a helicopter base, is a separate command on the west side of the New River. Site 48 is located in this area (Water and Air Research, 1983).

2.1.3 Topography and Surface Drainage

The generally flat topography of MCB Camp Lejeune is typical of the seaward portions of the North Carolina coastal plain. Elevations on the base vary from sea level to 72 feet above mean sea level (msl); however, the elevation of most of Camp Lejeune is between 20 and 40 feet above msl.

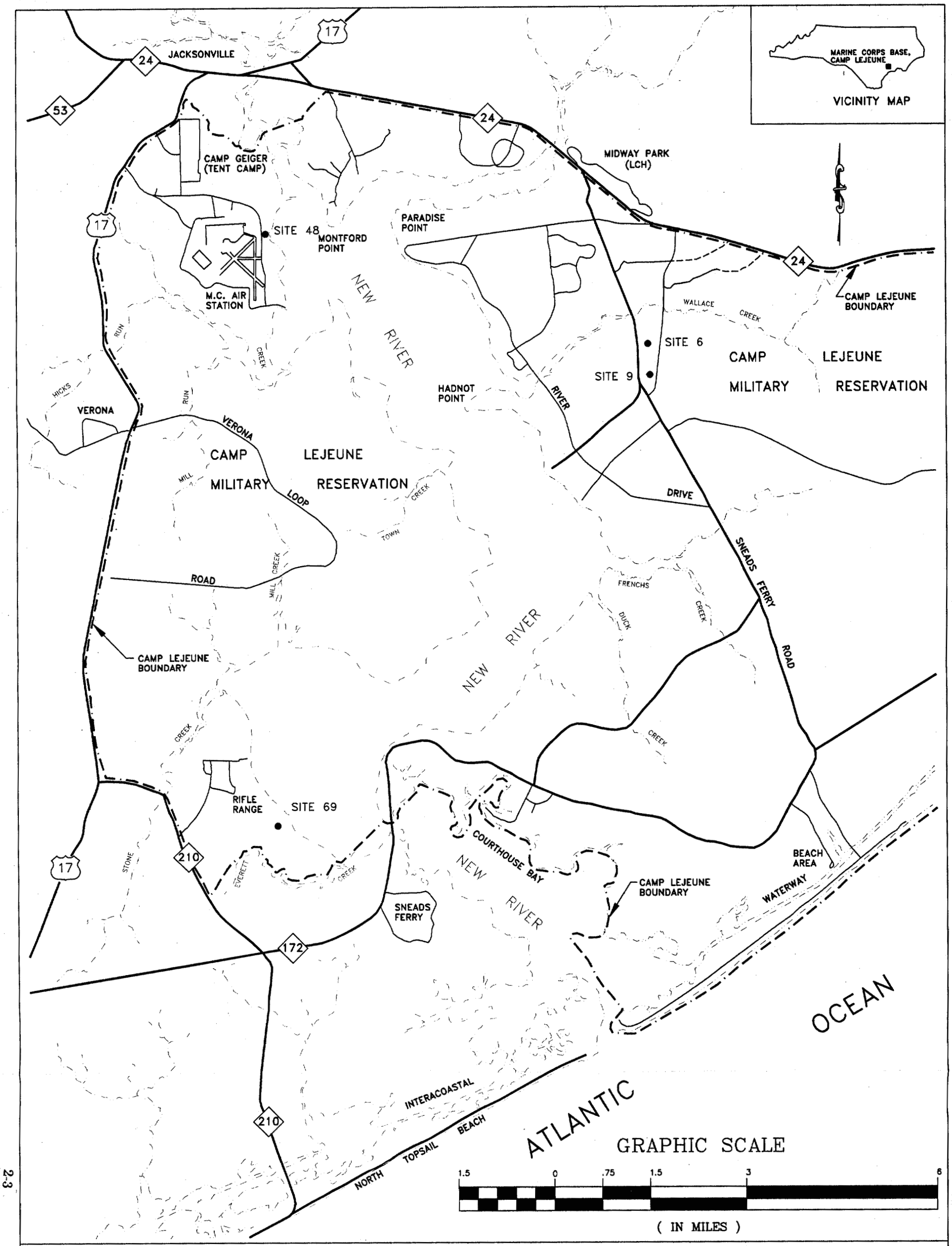


FIGURE 2-1
LOCATION MAP
SITES 6, 9, 48 & 69
MCB CAMP LEJEUNE, NORTH CAROLINA

05104AA01Z

Drainage at Camp Lejeune is generally toward the New River, except for areas near the coast, which drain into the Atlantic Ocean via the Intracoastal Waterway. In developed areas, natural drainage has been altered by asphalt, storm sewers, and drainage ditches. Approximately 70 percent of Camp Lejeune is in the broad, flat interstream areas. Drainage is poor in these areas and the soils are often wet (Water and Air Research, 1983). These poor drainage areas are not wetlands.

Flooding is a potential problem for base areas within the 100-year floodplain. The U.S. Army Corps of Engineers has mapped the limits of 100-year floodplain at Camp Lejeune at 7.0 feet above msl in the upper reaches of the New River (Water and Air Research, 1983). Only one of the four sites discussed in this RI/FS Work Plan, Site 48, is within the 100-year floodplain. The elevation of the 100-year floodplain increases downstream to 11 feet above msl near the coastal area (Water and Air Research, 1983).

2.1.4 Regional Geology

MCB Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the Atlantic Coastal Plain consist of interbedded sands, clays, calcareous clays, shell beds, sandstone, and limestone. These sediments are layered in interfingering beds and lenses that gently dip and thicken to the southeast (ESE, 1991). Regionally, they comprise 10 aquifers and nine confining units which overlie igneous and metamorphic basement rocks of pre-Cretaceous age. These sediments were deposited in marine or near-marine environments and range in age from early Cretaceous to Quaternary time. Figure 2-2 presents a generalized stratigraphic column for this area (ESE, 1991).

United States Geological Survey (USGS) studies at MCB Camp Lejeune indicate that the Base is underlain by seven sand and limestone aquifers separated by confining units of silt and clay. These include the water table (surficial), Castle Hayne, Beaufort, Peedee, Black Creek, and upper and lower Cape Fear aquifers. The combined thickness of these sediments is approximately 1,500 feet. Less permeable clay and silt beds function as confining units or semi-confining units which separate the aquifers and impede the flow of groundwater between aquifers. A generalized hydrogeologic cross-section of this area is presented in Figure 2-3. This cross-section illustrates the relationship between the aquifers in this area (ESE, 1991).

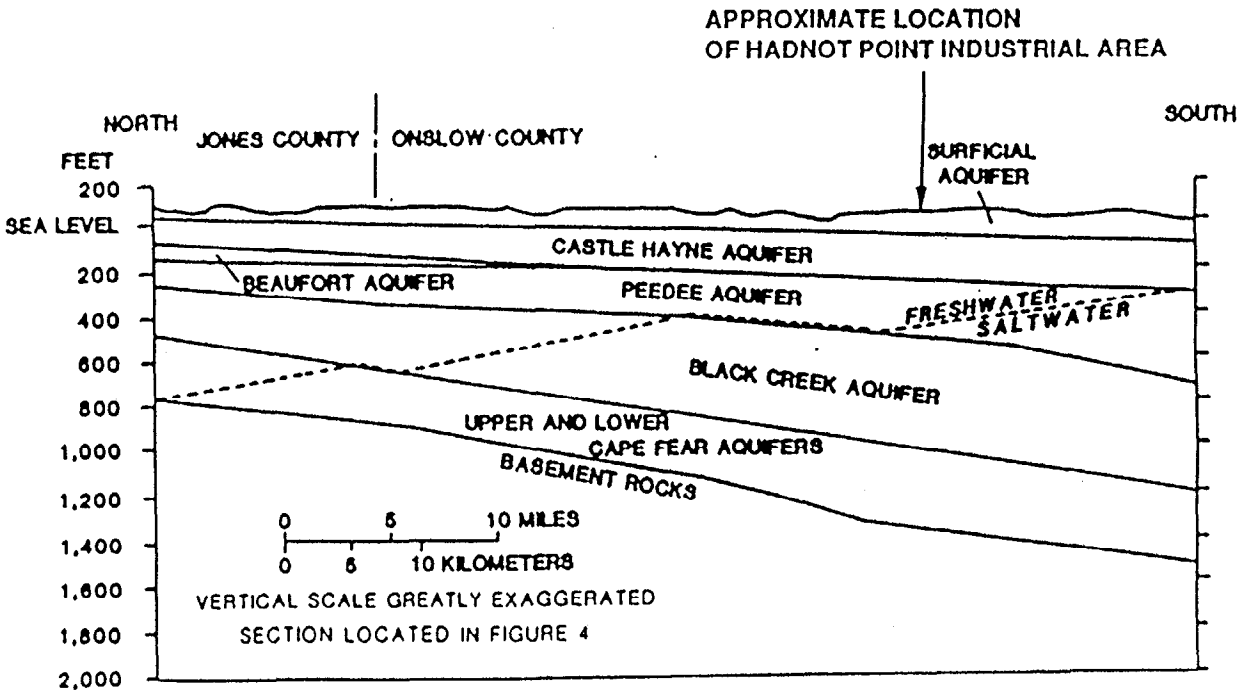
FIGURE 2-2

GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE COASTAL PLAIN OF NORTH CAROLINA

GEOLOGIC UNITS			HYDROGEOLOGIC UNITS
System	Series	Formation	Aquifer and Confining Unit
Quaternary	Holocene/Pleistocene	Undifferentiated	Surficial aquifer
Tertiary	Pliocene	Yorktown Formation(1)	Yorktown confining unit Yorktown aquifer
	Miocene	Eastover Formation(1)	Pungo River confining unit
		Pungo River Formation(1)	Pungo River aquifer
		Belgrade Formation(2)	Castle Hayne confining unit
	Oligocene	River Bend Formation	Castle Hayne aquifer
	Eocene	Castle Hayne Formation	Beaufort confining unit(3)
	Paleocene	Beaufort Formation	Beaufort aquifer
Cretaceous	Upper Cretaceous	Peedee Formation	Peedee confining unit Peedee aquifer
		Black Creek and Middendorf Formations	Black Creek confining unit Black Creek aquifer
		Cape Fear Formation	Upper Cape Fear confining unit Upper Cape Fear aquifer Lower Cape Fear confining unit Lower Cape Fear aquifer
	Lower Cretaceous(1)	Unnamed deposits(1)	Lower Cretaceous confining unit Lower Cretaceous aquifer(1)
Pre-Cretaceous basement rocks		--	--

(1) Geologic and hydrologic units probably not present beneath Camp Lejeune.
(2) Constitutes part of the surficial aquifer and Castle Hayne confining unit in the study area.
(3) Estimated to be confined to deposits of Paleocene age in the study area.

Source: Harned et al., 1989



SOURCE: ESE, 1991

FIGURE 2-3
GENERALIZED HYDROGEOLOGIC CROSS SECTION
JONES AND ONSLOW COUNTIES, NORTH CAROLINA
MCB CAMP LEJEUNE, NORTH CAROLINA

Baker
Baker Environmental, Inc.

2.1.5 Regional Hydrogeology

The following summary of regional hydrogeology was originally presented in Harned et al. (1989).

The surficial aquifer is a series of sediments, primarily sand and clay,which commonly extend to depths of 50 to 100 feet. This unit is not used for water supply on the Base. In some areas, the surficial aquifer is reported to contain water contaminated by waste disposal practices, particularly in the northern and north-central developed areas of the Base.

The principal water-supply aquifer for the Base is the series of sand and limestone beds that occur between 50 and 300 feet below land surface. This series of sediments generally is known as the Castle Hayne aquifer. The Castle Hayne aquifer is about 150 to 350 feet thick in the area and is the most productive aquifer in North Carolina.

Onslow County and Camp Lejeune lie in an area where the Castle Hayne aquifer contains freshwater, although the proximity of saltwater in deeper layers just below the aquifer and in the New River estuary is of concern in managing water withdrawals from the aquifer. Overpumping of the deeper parts of the aquifer could cause upcoming of saltwater to occur. The aquifer contains water having less than 250 mg/L (milligrams per liter) chloride throughout the area of the Base.

The aquifers that lie below the Castle Hayne consist of a thick sequence of sand and clay. Although some of these aquifers are used for water supply elsewhere in the Coastal Plain, they contain saltwater in the Camp Lejeune area.

Rainfall that occurs in the Camp Lejeune area enters the ground in recharge areas, infiltrates the soil, and moves downward until it reaches the water table, which is the top of the saturated zone. In the saturated zone, ground water flows in the direction of lower hydraulic head, moving through the system to discharge areas like the New River and its tributaries or the ocean.

Water levels in wells tapping the surficial aquifer vary seasonally. The surficial aquifer receives more recharge in the winter than in the summer when much of the water evaporates or is transpired by plants before it can reach the water table. Therefore, the water table generally is highest in the winter months and lowest in summer or early fall.

In confined aquifers, water is under hydraulic pressure (head) and the level to which it rises in a tightly cased well is called the potentiometric surface. The hydraulic head in a confined aquifer, such as the Castle Hayne, shows a different pattern of variation over time than that in an unconfined aquifer. Some seasonal variation also is common in the water levels of the Castle Hayne aquifer, but the changes tend to be slower and over a smaller range than for water-table wells.

2.1.6 Surface Water Hydrology

The following summary of surface water hydrology was originally presented in the IAS report (Water and Air Research, Inc., 1983).

The dominant surface water feature at MCB Camp Lejeune is the New River. It receives drainage from most of the base. The New River is short, with a course of approximately 50 miles on the central coastal plain of North Carolina. Over most of its course, the New River is confined to a relatively narrow channel entrenched in the Eocene and Oligocene limestones. South of Jacksonville, the river widens dramatically as it flows across less resistant sands, clays, and marls. At MCB Camp Lejeune, the New River flows in a southerly direction and empties into the Atlantic Ocean through the New River Inlet. Several small coastal creeks drain the area of MCB Camp Lejeune that is not drained by the New River and its tributaries. These creeks flow into the Intracoastal Waterway, which is connected to the Atlantic Ocean by Bear Inlet, Brown's Inlet, and the New River Inlet. (Water and Air Research, 1983).

Water quality criteria for surface waters in North Carolina have been published under Title 15 of the North Carolina Administrative Code. At MCB Camp Lejeune, the New River falls into two classifications, SC (estuarine waters not suited for body contact sports or commercial shellfishing) and SA (estuarine waters suited for commercial shellfishing). The SC classification applies to three areas of the New River at MCB Camp Lejeune including the Hadnot Point area. The rest of the New River at MCB Camp Lejeune falls into the SA classification (ESE, 1991).

2.1.7 Climatology

Marine Corps Base Camp Lejeune experiences mild winters and hot and humid summers. The average yearly rainfall is greater than 50 inches, and the potential evapotranspiration in the

region varies from 34 inches to 36 inches of rainfall equivalent per year. The winter and summer seasons usually receive the most precipitation. Temperature ranges are reported to be 33°F to 53°F in the winter (i.e., January) and 71°F to 88°F in the summer (i.e., July). Winds are generally south-southwesterly in the summer and north-northwest in the winter (Water and Air Research, 1983).

2.1.8 Natural Resources and Ecological Features

The following summary of natural resources and ecological features was obtained from the IAS Report (Water and Air Research, 1983).

The Camp Lejeune complex is predominantly tree-covered, with large amounts of softwood (shortleaf, longleaf, pond, and primarily loblolly pines) and substantial stands of hardwood species. Approximately 60,000 of the 112,000 acres of Camp Lejeune are under forestry management. Timber producing areas are under even-aged management with the exception of those areas along streams and swamps. These areas are managed to provide both wildlife habitat and erosion control. Forest management provides wood production, increased wildlife populations, enhancement of natural beauty, soil protection, prevention of stream pollution, and protection of endangered species.

Upland game species including black bear, whitetail deer, gray squirrel, fox squirrel, quail, turkey, and migratory waterfowl are abundant and are considered in the wildlife management programs.

Aquatic ecosystems on MCB Camp Lejeune consist of small lakes, the New River estuary, numerous tributaries, creeks, and part of the Intracoastal Waterway. A wide variety of freshwater and saltwater fish species exist here. Freshwater ponds are under management to produce optimum yields and ensure continued harvest of desirable fish species (Water and Air Research, 1983). Freshwater fish in the streams and ponds include largemouth bass, redbreast sunfish, bluegill, chain pickerel, yellow perch, and catfish. Reptiles include alligators, turtles, and snakes (including venomous).

Wetland ecosystems at MCB Camp Lejeune can be categorized into five habitat types: pond pine or pocosin; sweet gum/water oak/cypress and tupelo; sweet bay/swamp black gum and red maple; tidal marshes; and coastal beaches. Pocosins provide excellent habitat for bear and deer because these areas are seldom disturbed by humans. The presence of pocosin type

habitat at Camp Lejeune is primarily responsible for the continued existence of black bear in the area. Many of the pocosins are overgrown with brush and pine species that would not be profitable to harvest. Sweet gum/water oak/cypress and tupelo habitat is found in the rich, moist bottomlands along streams and rivers. This habitat extends to the marine shorelines. Dear, bear, turkey, and waterfowl are commonly found in this type of habitat. Sweet bay/swamp black gum and red maple habitat exist in the floodplain areas of Camp Lejeune. Fauna including waterfowl, mink, otter, raccoon, deer, bear, and gray squirrel frequent this habitat. The tidal marsh at the mouth of the New River is one of the few remaining North Carolina coastal areas relatively free from filling or other manmade changes. This habitat, which consists of marsh and aquatic plants such as algae, cattails, saltgrass, cordgrass, bulrush, and spikerush, provides wildlife with food and cover. Migratory waterfowl, alligators, raccoons, and river otter exist in this habitat. Coastal beaches along the intracoastal waterway and along the outer banks of Camp Lejeune are used for recreation and to house a small military command unit. Basic assault training maneuvers are also conducted along these beaches. Training regulations presently restrict activities that would impact ecological sensitive coastal barrier dunes. The coastal beaches provides habitat for many shorebirds (Water and Air Research, 1983).

The Natural Resources and Environmental Affairs (NREA) Division of MCB Camp Lejeune, the U.S. Fish and Wildlife Service, and the North Carolina Wildlife Resource Commission have entered into an agreement for the protection of endangered and threatened species that might inhabit MCB Camp Lejeune. Habitats are maintained at MCB Camp Lejeune for the preservation and protection of rare and endangered species through the base's forest and wildlife management programs. Full protection is provided to such species and critical habitat is designated in management plans to prevent or mitigate adverse effects of base activities. Special emphasis is placed on habitat and sightings of alligators, osprey, bald eagles, cougars, dusky seaside sparrows, and red-cockaded woodpeckers (Water and Air Research, 1983).

Within 15 miles of Camp Lejeune are three publicly owned forests: Croatan National Forest; Hofmann Forest; and Camp Davis Forest. The remaining land surrounding Camp Lejeune is primarily used for agriculture. Typical crops include soybeans, small grains, and tobacco (Water and Air Research, 1983).

2.1.9 Land Use

Camp Lejeune presently covers an area of approximately 170 square miles. Military and civilian population is approximately 60,000. During World War II, Camp Lejeune was used as a training area to prepares Marines for combat. This has been a continuing function of the facility during the Korean and Vietnam conflicts, and the recent Gulf War (i.e., Desert Storm). Toward the end of World War II, the camp was designated as a home base for the Second Marine Division. Since that time, Fleet Marine Force (FMF) units also have been stationed here as tenant commands.

2.2 Site 6 - Storage Lots 201 and 203

This section addresses the background and setting of Site 6 (Storage Lots 201 and 203)

2.2.1 Site Location and Setting

Site 6 is located approximately 1.75 miles east of the New River and 2 miles south of Route 24 on the Mainside portion of Camp Lejeune (see Figure 2-1). The site is bordered to the west by Holcomb Boulevard, to the north by Wallace Creek, to the east by Piney Green Road, and to the south by Site 9 (Fire Fighting Training Pit). Site 6 is comprised of two storage lots, Lot 201 and 203, which are surrounded by woodlands. The wooded areas are considered a part of this site for purposes of this RI/FS since debris have been noted throughout. Site 6 encompasses approximately 225 acres. The site is depicted in Figure 2-4.

Storage Lot 201 is located in the south-central portion of the site. This lot, which is actively used to store military equipment (e.g., vehicles, lumber, hydraulic oils and lubricants, non-PCB transformers and other supplies), is bordered by woods to the north, Holcomb Boulevard to the west, Piney Green Road to the east, and Bear Head Creek to the south. With the exception of Holcomb Boulevard to the west, the lot is surrounded by fields and woodlands. This lot is approximately 25 acres in size (ESE. 1990).

Storage Lot 203 is situated in the northern portion of Site 6, just north of Storage Lot 201. Storage Lot 203 is bordered to the west by Holcomb Boulevard, the north by Wallace Creek, to the east by Piney Green Road, and to the south by woodlands as shown in Figure 2-4. A fence is present around the lot; however, the actual area of the storage lot may slightly exceed the fenceline. This lot is approximately 46 acres in size (ESE, 1990).

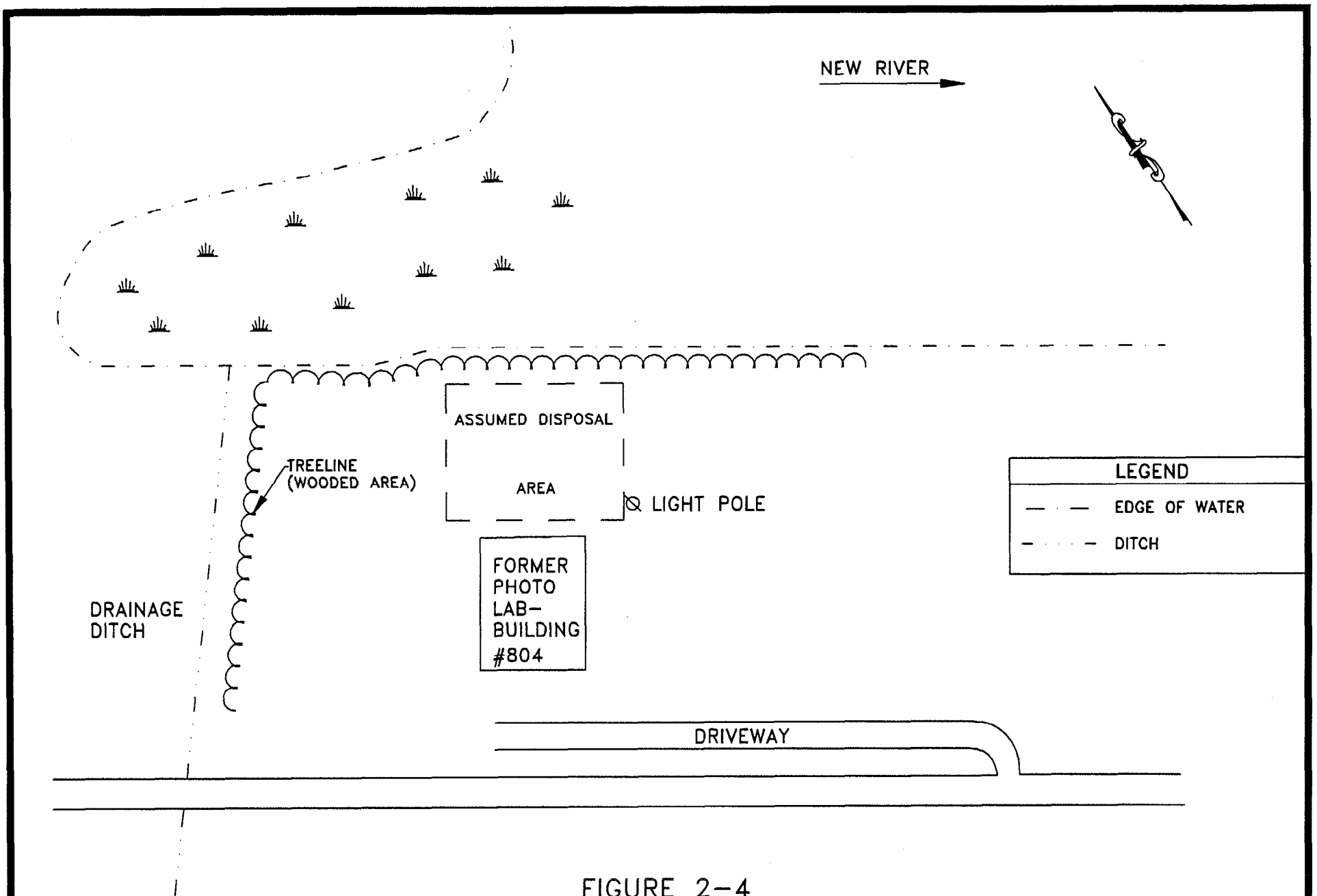


FIGURE 2-4
SITE 48
MCAS MERCURY DUMP
N.T.S.

Lot 203 is littered with debris. Figure 2-5 (not to scale) has been provided for purposes of identifying the approximate locations and types of debris noted during a site reconnaissance conducted in September 1991. The index to Figure 2-5 lists the debris noted during the reconnaissance.

Woods and open fields surround both lots and make up the remaining area of Site 6. The fields and woodlands are littered throughout (randomly) with debris including rocket casings, and empty and rusted drums. No markings could be noted on any of the drums due to their condition and age. Many of the drums were only fragments as opposed to "whole" drums. Portions of these woodlands may have been disturbed by disposal activities. Portions of the area between Lot 203 and Wallace Creek may have been disturbed by excavation activities based on the topography and vegetative cover of these areas. Debris were noted throughout these areas. The debris (casings and drum fragments) were noted to be extruding from the ground surface in some of the areas. The wooded portion of land along Wallace Creek and Bear Head Creek did not appear to be disturbed.

2.2.2 Site Topography and Drainage

The land within Lot 201 is flat (approximately 25 feet above msl) and unpaved. The area is devoid of vegetation due to vehicular traffic. Site drainage is toward Bear Head Creek, which is approximately 5 feet above msl and is tidal influenced. Drainage from the woodlands which border Lot 201 to the north and east is toward the lot area. The woods between Lot 201 and Bear Head Creek is thick with vegetation.

Most of Lot 203 within the fence is between 25 and 30 feet above msl, and is for the most part flat and unpaved. Most of the area within Lot 203 is thick with vegetation. The wooded areas which border the lot to the east, west, and south are slightly higher in elevation (approximately 30 to 35 feet above msl). The wooded areas surrounding the lot also consists of thick underbrush. The topography of the woodlands to the north of Lot 203 dips toward Wallace Creek (see Figure 2-4). Wallace Creek is influenced by tides.

A deep cutting ravine is present in the north-central portion of the lot. The fence which surrounds the lot was constructed around the ravine due to its steep sides (see Figure 2-4). Drainage entering the ravine flows into Wallace Creek.

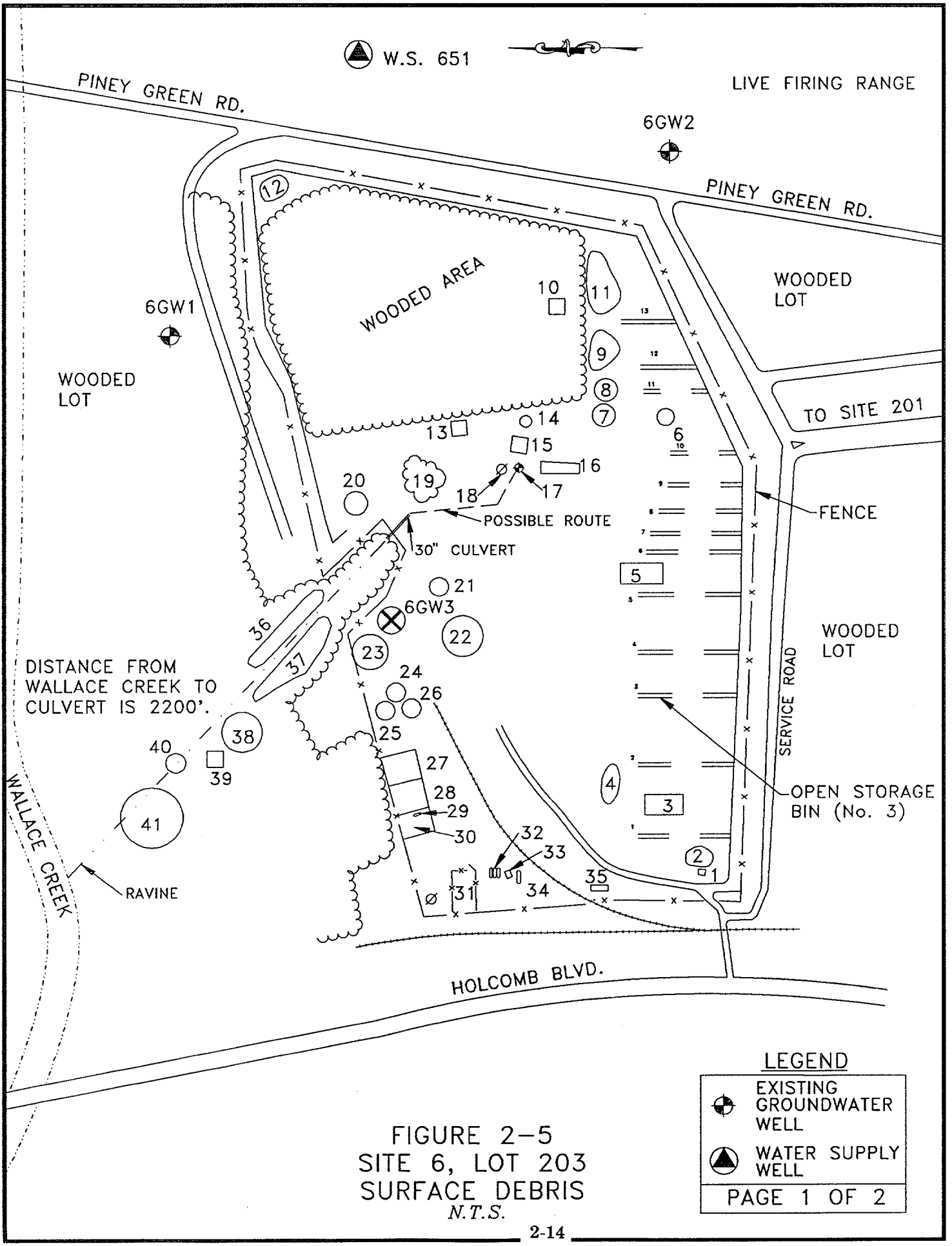


FIGURE 2-5
SITE 6, LOT 203
SURFACE DEBRIS
N.T.S.

INDEX TO FIGURE 2-5
(Page 2 of 2)

1	Trailer
2	5 Drums with Stained Soil
3	Drums
4	Pile of Fiberglass-like material
5	Drums on Pallets and Formerly Fenced In Area
6	14 Metal Drums
7	20 Metal Drums
8	Two Drums with Tricresyl Phosphate
9	Soil Mound - 6 to 9 feet tall x 75 feet long x 25 feet wide
10	3 Truck Batteries
11	Metal Debris - 15-18 feet tall x 100 feet long x 50 feet wide
12	Reported Possible DDT and PCB Disposal Area
13	Three Crates of Metal Cleaning Solution
14	Shredded Tire Pile
15	Non-PCB Electric Transformer
16	Stacked Wooden Ammunition Boxes
17	Scrap
18	Light Pole #4
19	Clump of Trees with Debris Dispersed Throughout
20	Shredded Tire Pile
21	Pile of Rafts - 8-10 feet tall x 30 feet long x 30 feet wide
22	Pile of Rubber Cleated Tank Treads - 15-18 feet tall x 50 feet long x 50 feet wide
23	Minefield Clearing Training Kits - 8 feet tall 18 feet wide x 20 feet long
24	M-16 Shells
25	Eleven Plastic Drums Labeled "Corrosives"
26	Bazooka Rockets - 5-6 Rockets
27	Radio Parts and Batteries
28	Broken Electric Fans
29	Compressed Gas Cylinder
30	Acid Container Storage Area
31	Fenced in Area - Former Use Unknown
32	Three 250-Gallon ASTs
33	Office Shed
34	Five Hundred Gallon AST (Diesel Fuel)
35	Truck Scale
36	Commodes
37	Cabinets, Steel Drums, Rolls of Fencing
38	Ovens, with Possible Asbestos Linings
39	Pool of Water with Batteries and Debris
40	Approximate 100-foot x 50-foot area with Cans, Tires, Respirator Cartridges
41	Rusty, Empty Drums; Tires; Respirator Canister Filters

2.2.3 Site History

Site 6 has a long history of various uses, including the disposal and storage of wastes and supplies.

Lot 201 is currently used to store military equipment and supplies. No disposal activities have been documented at Lot 201. Pesticides have been reportedly stored in the northeast and southeast portions of Lot 201 (Water and Air Research, 1983). Transformers containing PCBs were reportedly stored in the southwest portion of Lot 201.

Lot 203 has served as a waste disposal area from as early as the 1940s. The reports of disposal activities are vague; there is no indication of the types or quantities of material disposed of throughout the lot with the exception of pesticides. The pesticide DDT is reported to have been disposed of at the southeast portion of this lot. However, the areal extent of disposal is unknown since there is no visual evidence that may help define the disposal area(s). The quantity of DDT disposed of is also unknown. PCB transformers also were reportedly stored in the northeast portion of Lot 203 (Water and Air Research, 1983).

Lot 203 may have been used as a borrow pit according to Camp Lejeune Environmental Management Division. There is no documentation to support this; however, a driller's log from a monitoring well borehole notes that a passerby indicated to the drilling crew that "a lot was buried under the site". No other information is available to determine what materials were buried or the areas where these alleged disposal practices occurred. There are no mounds, depressions, or obvious stressed vegetation which could indicated where past disposal activities may have occurred.

The surface of Lot 203, however, is littered with drums and debris. The site, previously used for storage and disposal, has been closed. The following items were observed during Baker's September 1991 site reconnaissance in the main portion of the site: various empty and full 55-gallon drums, ordnance, expended demolition kit training materials, fiberglass-type material, a non-PCB electrical transformer, sheet metal debris, radio/communication parts, aboveground storage tanks (empty), crates of metal cleaner, shredded tires, wire cables, empty ammunition boxes, barbed wire fencing, plastic containers, empty shipping crates and disposal bins, and wooden pallets. The type of materials observed in the ravine included: batteries, empty unlabeled drums, wire cables, glass jars, commercial ovens, commodes, and respirator cartridges. Figure 2-5 identifies the approximate locations of the items observed during

Baker's site visit. Most of these items, with the exception of the drums, batteries, and general debris (i.e., shipping crates, pallets, sheet metal, boxes), appear to be located in defined areas. Drums were observed in small groupings of 20 or less throughout the site. The majority of the full drums, if labeled, were identified as containing lubricants, petroleum products, or corrosives. The aboveground tanks were labeled as containing diesel, gasoline, and kerosene. A more detailed description of the individual disposal areas observed during Baker's site visit are presented in Section 3.0 of this report. Figure 2-5 illustrates the location of these materials.

2.2.4 Site Geology and Hydrogeology

Previous investigative efforts at Site 6 did not include geologic investigations within the scope of work. Site specific geologic information is limited to information obtained during the construction of monitoring wells. In addition, only shallow monitoring wells have been installed to date.

The site is reportedly underlain by silty sand, sand, and coarse sand. The water table was measured at depths ranging from 2 to 15 feet in April 1987 (ESE, 1990) and at depths ranging from 7 to less than 23 feet in January 1991 (ESE, 1991). Well locations are shown on Figure 2-4. Table 2-1 provides a summary of groundwater elevations.

Groundwater is reported to flow radially toward Wallace Creek and Bear Head Creek. A groundwater divide may be present between Lot 201 and 203, based on a review of existing groundwater level data. Flow gradients based on the April 1987 data are reported to be approximately 0.009 feet per foot (ft/ft) (ESE, 1990). Groundwater gradients based on the January 1990 data are not as steep due to the lower water table (0.003 ft/ft).

2.2.5 Previous Investigations and Findings (Lot 201)

In response to the passage of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) in 1980, the Department of the Navy (DoN) initiated the Navy Assessment and Control of Installation Pollutants (NACIP) program to identify, investigate, and clean up past hazardous waste disposal sites at Navy installations. The NACIP investigations were conducted by the Naval Energy and Environmental Support Activity (NEESA) and consisted on Initial Assessment Studies (IAS) and Confirmation Studies. Initial Assessment Studies are similar to the U.S. EPA's Preliminary Assessments/Site

TABLE 2-1

SITE 6 GROUNDWATER ELEVATIONS AND WELL SPECIFICATIONS
MCB CAMP LEJEUNE, NORTH CAROLINA

Well No.(1)	Elevation TOC(2) (feet)	Elevation LS (feet)	Stick-Up (feet)	Elevation Bottom of Screen(3) (feet)	4/15/87		1/18 - 1/19/91	
					DTW - TOC (feet)	Elev - GW (feet)	DTW - TOC (feet)	Elev - GW (feet)
6GW1	120.83	118.41	2.42	93.41	17.08	103.75	>22	<98
6GW2	124.02	121.86	2.16	96.86	12.17	111.85	18.05	105.97
6GW3	116.99	114.74	2.25	89.74	14.92	102.07	17.96	99.03
6GW4	113.45	111.00	2.45	86.00	7.42	106.03	11.02	102.43
6GW5	111.06	108.73	2.33	83.73	6.42	104.64	9.80	101.26
6GW6	112.09	109.77	2.32	84.77	7.58	104.51	11.20	100.89
6GW7	101.48	99.21	2.27	74.21	5.21	96.27	7.05	94.43
6GW8	105.98	104.91	1.07	79.91	6.13	99.85	8.52	97.46

Notes: TOC = Top of Casing
LS = Land Surface
DTW = Depth to Water

(1) All wells constructed of 2-inch PVC casing and Schedule 40 PVC screen.
(2) All measured elevations are relative to the site (e.g., the site is only 20 feet above msl but the reported elevation is higher than the actual elevation).
(3) All well screen bottoms were constructed 25 feet below ground surface. Screen lengths are all 20 feet.
Source: ESE, 1991 (Table 4-1 and Appendix B).

Investigations (PA/SI). Confirmation Studies are similar to EPA's RI/FS. When the Superfund Amendment and Reauthorization Act (SARA) was passed in 1986, the DoN dissolved the NACIP in favor of the Installation Restoration Program (IRP), which adopted EPA Superfund terminology and procedures (ESE, 1991).

The IAS was conducted by Water and Air Research, Inc., in 1983. The IAS identified a number of sites at MCB Camp Lejeune as potential sources of contamination, including the sites discussed in this RI/FS Work Plan. As a result of this study, Environmental Science and Engineering, Inc. (ESE) was contracted by LANTDIV to investigate these sites. Since then, Baker Environmental, Inc. (Baker) was contracted in 1991 under the DoN's Comprehensive Long-Term Environmental Action Navy (CLEAN) Program to continue RI/FS activities at the sites identified in this RI/FS Work Plan.

The initial ESE investigation, referred to as a Confirmation Study, focused on those areas identified in the IAS. The Confirmation Study is divided into two investigation steps: the Verification Step and the Characterization Step. A final investigation, referred to as a Supplemental Characterization, was added to collect additional information to complete a Site Assessment (SA). These investigations are summarized in this section. Additional information can be obtained from Site Assessment Report for Sites 6, 48, and 69, Characterization Study to Determine Existence and Possible Migration of Specific Chemicals In Situ (ESE, 1991).

2.2.5.1 Soil Investigations

In August 1984, as part of the Verification Step, ESE drilled and sampled ten soil borings at Lot 201. The sampling locations are unknown. Each of the 10 samples was composited from the 0-to-3 foot depth range. The samples were only analyzed for the o,p- and p,p-isomers of DDD, DDE, and DDT (ESE, 1991). It is not known why only these pesticides were analyzed except that pesticides were reportedly stored at Lot 201. The analytical results indicate that DDT,pp was detected in all ten samples. DDD,op; DDT,op; DDD,pp; and DDE,pp were detected in 8 of the 10 samples. DDE,op was detected in 6 of the 10 samples. The maximum detected concentrations for each of the isomers were: DDD,op (0.03640 µg/g); DDE,op (0.0320 µg/g); DDT,op (0.3240 µg/g); DDD,pp (0.1600 µg/g); DDE,pp (0.7700 µg/g); and DDT,pp (0.1400 µg/g). No information is available to assess the analytical methods employed or the Quality Assurance (Quality Control (QA/QC) protocols used in the field or laboratory.

2.2.5.2 Groundwater Sampling

In November 1986, as part of the Characterization Step, four shallow monitoring wells (wells 6GW4, 6GW5, 6GW6, and 6GW7) were installed and sampled at Lot 201 (see Figure 2-4). A second sampling round was conducted in January 1987. Both rounds of samples were analyzed for VOCs and the o,p- and p,p-isomers of DDD, DDE, and DDT. DDD, DDE, and DDT were not detected in any groundwater sample in either round. One VOC was detected in the first round of sampling: chloromethane (6.5 µg/l) was detected in well 6GW6 (ESE, 1990a).

In January 1991, the four existing monitoring wells were sampled and analyzed for full TCL parameters. This sampling was conducted by ESE as part of the Supplemental Characterization Investigation (ESE, 1991). Carbon disulfide was detected at a concentration of 10 µg/l in well 6GW6. No semivolatiles or pesticides were detected in any of the groundwater samples. The following inorganic parameters were detected in concentrations exceeding the North Carolina Water Quality Standards: iron, manganese, chromium, lead, and barium. One or more of these inorganic constituents were observed in all four shallow wells.

2.2.5.3 Surface Water Sampling

As part of the Characterization Step in November 1986, one upstream and one downstream surface water sample were collected in Bear Head Creek. These samples were analyzed for VOCs, and the o,p- and p,p-isomers of DDD, DDE, and DDT (ESE, 1991). No analyzed compounds were detected in the surface water samples collected in Bear Head Creek.

2.2.5.4 Sediment Sampling

As part of the Characterization Step in November 1986, one upstream and one downstream sediment sample were collected in Bear Head Creek. These samples were analyzed for VOCs, and the o,p- and p,p-isomers of DDD, DDE, and DDT (ESE, 1991). VOCs were not detected in any sample. The p,p-isomers of DDE, and DDT were detected in the sediments collected from Bear Head Creek at levels of 0.0758 µg/g (or ppm) and 0.0131 µg/g, respectively. The upstream concentrations of these two isomers were higher than the downstream concentrations. The source of upstream sediment contamination was not reported and is presently unknown. Historical mosquito control practices may have resulted in the presence of these pesticides in Beas Head Creek sediments.

2.2.6 Previous Investigations and Findings - Lot 203

This section summarizes the results of previous soil, groundwater, and surface water and sediment investigations at Lot 203.

2.2.6.1 Soil Investigations

In August, 1984, as part of the Verification Step, ESE drilled and sampled 10 soil borings at Lot 203. The sampling locations are unknown. Each of the 10 samples was composited from the 0-to-3 foot depth range. Two duplicate samples were also collected. The samples were only analyzed for the o,p- and p,p-isomers of DDD, DDE, and DDT (ESE, 1991). The p,p-isomer of DDD,DDE, and DDT were predominant in these samples. DDE,pp was detected in 10 of the 12 samples; DDD,pp was detected in 7 of the 12 samples; and DDT,pp was detected in 6 of the 12 samples. DDE,op was not detected in any of the samples. The maximum detected concentrations for each of the other five isomers were: DDD,op (0.00137 µg/g); DDT,op (0.01580 µg/g); DDD,pp (0.0048 µg/g); DDE,pp (0.0016 µg/g); and DDT,pp (0.0490 µg/g).

2.2.6.2 Groundwater Sampling

In November 1986, as part of the Characterization Step, four shallow monitoring wells (wells 6GW1, 6GW2, 6GW3, and 6GW4) were installed and sampled to monitor groundwater quality near Lot 203. A second sampling round was conducted in January 1987. Both rounds of samples were analyzed for VOCs and the o,p- and p,p-isomers of DDD, DDE, DDT. DDD, DDE, and DDT were not detected in any groundwater sample in either round. Only two VOCs were detected in the first round of sampling in well 6GW1: benzene (3.1 µg/l) and 1,1,2,2-tetrachloroethane (63 µg/l) (ESE, 1990a).

In January 1991, three of the four existing monitoring wells and two water supply wells were sampled to assess groundwater quality at Lot 203. The fourth monitoring well was dry and therefore could not be sampled (ESE, 1991). The sampling was conducted by ESE as part of the Supplemental Characterization Investigation. The samples were analyzed for full TCL parameters. Detectable concentrations of VOCs were identified only in the water supply wells: acetone (12 µg/l); vinyl chloride (70 µg/l); 1,2-dichloroethene (75 µg/l); trichloroethene (13 µg/l); and tetrachloroethene (53 µg/l). The water supply wells (No. 651 and No. 653) are located north of Piney Green Road. No semivolatiles or pesticides were detected in any of the

groundwater samples, including those samples collected from the potable water supply wells. Several inorganic parameters were detected in concentrations exceeding the North Carolina Water Quality Standards. These compounds included: iron, manganese, chromium, lead, cadmium, and zinc. Every monitoring well had at least one or more elevated inorganic compound.

2.2.6.3 Surface Water Sampling

As part of the Characterization Step in November 1986, one upstream and one downstream surface water sample were collected in Wallace Creek. These samples were analyzed for VOCs, and the o,p- and p,p-isomers of DDD,DDE, and DDT (ESE, 1991). The following VOCs were detected: trans-1,2-dichloroethene (6.4-35 µg/l), trichloroethene (<3-26 µg/l), and vinyl chloride (1.9-3.6 µg/l). The downstream concentrations of each of these VOCs were higher than the upstream concentrations. DDD, DDE, and DDT were not detected in any sample.

As part of the Supplemental Characterization Investigation in January 1991, two surface water samples were collected from Wallace Creek. The upstream location was at Piney Green Road, and the downstream location was at Holcomb Boulevard. The samples were analyzed for full TCL parameters. In addition, field measurements of pH, specific conductivity, and temperature were made (ESE, 1991). One VOC was detected in the downstream sample: trichloroethene (5 µg/l). Semivolatiles and pesticides were not detected in any sample. Most of the detected inorganics (aluminum, calcium, magnesium, potassium, sodium, and zinc) all increased in concentration from upstream to downstream. Iron was the only detected inorganic which decreased in concentration upstream to downstream.

2.2.6.4 Sediment Sampling

As part of the Characterization Step in November 1986, one upstream and one downstream sediment sample were collected in Wallace Creek. These samples were analyzed for VOCs, and the o,p- and p,p-isomers of DDD,DDE, and DDT (ESE, 1991). No compounds were detected in either of the samples.

As part of the Supplemental Characterization Investigation in January 1991, two sediment samples were collected from Wallace Creek. The upstream location was at Piney Green Road, and the downstream location was at Holcomb Boulevard. The samples were analyzed for full TCL parameters. In addition, field measurements of pH, specific conductivity, and

temperature were made (ESE, 1991). Two common laboratory solvents (acetone and methylene chloride) were the only VOCs detected in the samples. Semivolatiles were not detected in the upstream sediment sample. In the downstream sample, four semivolatiles were detected: chrysene (420 µg/kg), benzo(b)fluoranthene (600 µg/kg), benzo(k)fluoranthene (510 µg/kg), and benzo(a)pyrene (460 µg/kg). Pesticides were not detected in either sample. With respect to inorganic compounds, aluminum, calcium, chromium, iron, manganese, and zinc were detected in the upstream sediments. Of these, calcium and manganese were not detected downstream. In general, the upstream concentrations were higher than the downstream concentrations.

2.3 Site 9 - Fire Fighting Training Pit

This section addresses the background and setting of Site 9 (Fire Fighting Training Pit).

2.3.1 Site Location and Setting

Site 9 is located between Piney Green Road and Holcomb Boulevard along the southern border of Site 6. Bear Head Creek is located approximately 500 feet to the north of the site. This site is bordered by local streets to the east and west and encompasses an area of approximately 2 acres. An adjacent property borders the site to the west as shown on Figure 2-4. An asphalt-lined pit is present at this site. This pit is currently used to conduct training exercises for extinguishing fires. An oil/water separator is located just south of the pit as shown on Figure 2-4. It is not known where the water is discharged to after it is separated from the fuel. The fuel is collected and reused, or properly disposed.

Three above ground storage tanks are located just west-northwest of the training pit. These tanks contain fuels used to create the fires. The types of fuels are unknown, but they could potentially contain jet fuel (JP-4 and JP-5) based on markings noted on these tanks. A "do not use" sign was noted on one of the three tanks.

Several buildings were noted in the immediate area. With the exception of the fire tower (smoke house), which is located at the northern portion of the site, the use and contents of the surrounding buildings are unknown. None of the buildings are located within the site boundary.

2.3.2 Site Topography and Drainage

The site is flat (approximately 25 feet above msl) and unpaved. Grass and/or gravel make up the ground surface. A gravel road is present along the western portion of the site, abuting a fence which separates an adjacent property. A paved roadway borders the site to the south and east. Site drainage is northward toward Bear Head Creek. The topography begins to slope downward just north of the Site (see Figure 2-4). Immediate drainage near the fire pit may be impeded from migrating since the surrounding roadways are slightly higher in elevation.

2.3.3 Site History

Site 9 has been used for fire fighting training exercises from the 1960s to the present. Until 1981, training exercises were conducted in an unlined pit. The pit is currently asphalt-lined. Flammable liquids including used oil, solvents, and contaminated fuels (non-leaded) were burned in the pit. No information is available to determine whether chemical fire retardants were used to extinguish the fires. Approximately 30,000 to 40,000 gallons per year of JP-4 and JP-5 fuels were used during training exercises.

2.3.4 Site Geology and Hydrogeology

The geology underlying Site 9 is reportedly similar to Site 6. The surficial geology is mainly comprised of sand and silty sand. Shallow groundwater flows northward toward Bear Head Creek (ESE, 1990). A gradient of approximately 0.026 ft/ft has been reported (ESE, 1990). A limited amount of information is available for this site since only three wells have been installed to date. No boring logs or well logs are available to assess subsurface features and well specifications.

2.3.5 Previous Investigations and Findings

Previous investigations at Site 9 only focused on groundwater. No soil investigations or supplemental investigations of Bear Head Creek (i.e., over and above the studies conducted on Bear Head Creek that were associated with Site 6) have been conducted.

Two monitoring wells (9GW1 and 9GW2) were installed in 1984 to characterize groundwater quality (see Figure 2-4). A water supply well (No. 639) located just east of Piney Green Road was also included in the investigation. The two shallow wells and the water supply wells were

sampled on July 5, 1984 and analyzed for cadmium, chromium, lead, oil and grease, volatile organics, and total phenols. The results are provided on Table 2-2.

In November 1986, a third shallow well was installed at the northeastern corner of the site downgradient of the pit. Samples were collected from all three shallow wells between November 18 and 19, 1986 and analyzed for xylene, methyl ethyl ketone, methyl isobutyl ketone, ethylene dibromide, and hexavalent chromium. The results are presented on Table 2-2.

Chromium, lead, and phenols were detected in wells 9GW1 and 9GW2 during the 1984 sampling round. As shown on Figure 2-4, these wells are located in the southeastern and northeastern corner of the site, respectively. No target analytes were detected in the water supply well. The water supply well was only sampled in 1984.

The sampling round of 1986 also exhibited the presence of these contaminants in well 9GW1. Well 9GW2 did not exhibit lead above 22 µg/l (it is not known whether this is the instrument or the method detection level); however, both chromium and phenols were detected again in this well. Well 9GW3 exhibited phenols and 1,2-dibromoethane (ethylene dibromide). Well 9GW3 was again sampled in January 1987 (the other two wells were not sampled) and exhibited low levels of chromium and lead (below Federal or State water quality standards) (ESE, 1990).

The analytical methods or quality of data were not reported in the reference documents and therefore are currently unknown.

2.4 Site 48 - MCAS Mercury Dump

This section addresses the background and setting of Site 48 (MCAS Mercury Dump).

2.4.1 Site Location and Setting

The Marine Corps Air Station (MCAS) Mercury Dump is located west of the New River between the MCAS and the banks of the New River (see Figure 2-1). The site is defined as the area between Longstaff Road and the New River, behind Building 804 (see Figure 2-6). It is difficult to define the boundary of this site since little is known about the extent of mercury disposal activities. However, for purposes of this RI/FS, the site will be preliminarily defined

TABLE 2-2

SITE 9 - FIRE FIGHTING TRAINING PIT
DETECTED TARGET ANALYTES IN GROUNDWATER SAMPLES
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	9GW1 7/5/84	9GW1 11/19/86	9GW2 7/5/84	9GW2 11/19/86	WSW639 7/5/84	9GW3 11/18/86	9GW3 1/21/87
Chromium	45	36.2	86	79	<6.0	<5.4	30
Lead	80	41.6	94	<22	<40	<22	31
Oil & Grease	3	<0.2	<0.7	<0.2	<0.8	<0.2	0.2
Phenols	3	6	4	6	<1	5	<2
1,2-Dibromoethane	NRQ	<0.020	NRQ	<0.020	NRQ	0.157	<0.01

NRQ = Analysis not requested.

Note: Values reported are concentrations in micrograms per liter (ug/L); this approximates parts per billion (ppb).

Source: ESE, 1990.

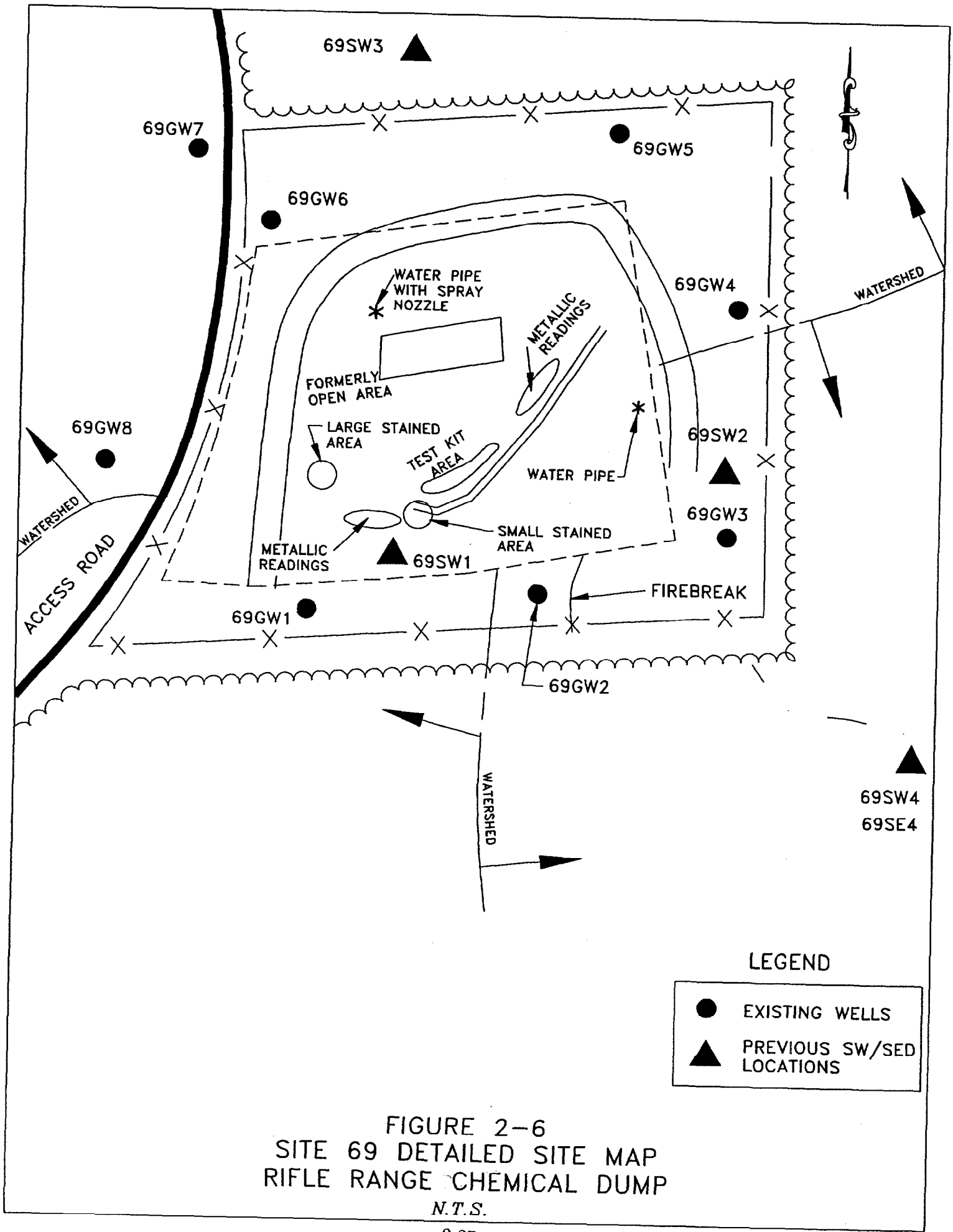


FIGURE 2-6
SITE 69 DETAILED SITE MAP
RIFLE RANGE CHEMICAL DUMP
N.T.S.

as the area which is bordered by the New River to the east, a drainage ditch to the north, Longstaff Road to the west, and Building AS811 to the south. The southern boundary can not be defined by any natural or manmade boundary since the area is flat and covered with grass.

Building 804, which formerly operated as a photo lab, is located at the center of this site. The area immediately surrounding this building is grass covered and maintained (i.e., the grass is mowed). The grass area extends to the banks of the New River. Young saplings and heavy vegetation line the property along the banks of the New River and the drainage ditch. There is no apparent stressed vegetation in the grassy area which surrounds the building. However, during a site reconnaissance by LANTDIV personnel, some stressed vegetation was noted near the edge of the property near the border of the New River.

2.4.2 Site Topography and Drainage

The site is situated at an elevation of approximately 5 feet above msl. The land is primarily flat, but dips sharply at the very edge of the property to the shoreline of the New River. Overland drainage is unlikely over most of the site due to the flat topography. Drainage along the edge of the property, beginning where saplings and brush border the banks of the New River, is toward the New River.

2.4.3 Site History

Building 804 was once used a photo lab during the period 1956 to 1966. It has been reported that metallic mercury was periodically drained from the delay lines of the radar units and disposed in a 100 to 200 foot wide corridor extending from the rear of the building to the New River. Approximately one gallon per year of mercury was disposed of during a ten-year period. The mercury was reportedly carried by hand and dumped or buried in small quantities at randomly selected areas (Water and Air Research, 1983).

2.4.4 Site Geology and Hydrogeology

There have been no previous studies or investigations relating to groundwater at this site. The water table is expected to be high since the ground surface is at an elevation of 5 feet above msl. Groundwater flow direction is likely towards the New River, but can be expected to be influenced by the tide. Other geologic investigations conducted at nearby sites located

about one-half mile from Site 48 (at MCAS) have exhibited both a surficial aquifer underlain by a deeper semi-confined aquifer (i.e., Castle Hayne).

2.4.5 Previous Investigations and Findings

This section summarizes the results of previous soil, sediment, surface water and aquatic investigations.

2.4.5.1 Soil Investigations

As part of the Verification Step in August 1984, five soil samples (including a duplicate sample) were collected from four soil borings at Site 48. None of the sampling locations are known. The samples were collected immediately above the soil-groundwater interface. All of the samples were analyzed for mercury. Mercury was detected in all five samples at concentrations ranging from 0.009 mg/kg to 0.03 mg/kg (ESE, 1991). The analytical methods and level of data quality are unknown.

2.4.5.2 Groundwater Sampling

No groundwater sampling has been conducted at the MCAS Mercury Dump Site.

2.4.5.3 Surface Water Sampling

As part of the Supplemental Characterization Investigation conducted in January 1991, ten surface water samples were collected from the marsh area and inlet northeast of Building 804. In addition, one sample was collected in the New River at an upstream (background) location outside of the marsh area. The samples were analyzed for TCL metals (ESE, 1991). Calcium, iron, magnesium, potassium, and sodium were detected in all of the samples, including the background sample. Mercury was not detected in any of the samples. Other typical metals of concern (i.e., arsenic, cadmium, chromium, and lead) were not detected in any sample.

2.4.5.4 Sediment Sampling

As part of the Verification Step conducted in August 1984, four sediment samples were collected from the marshy area to the north of Building 804 and analyzed for mercury. However, it is not clear exactly where these samples were collected or what area was

specifically referred to as "the marsh." Mercury was detected in all four samples at concentrations ranging from 0.02 mg/kg to 0.03 mg/kg.

As part of the Supplemental Characterization Investigation conducted in January 1991, ten sediment samples plus one duplicate sample were collected from the marsh area and inlet northeast of Building 804. Again, the sampling locations were not identified. In addition, one sample was collected in the New River at an upstream (background) location outside of the marsh area. The samples were analyzed for TAL metals. Aluminum, iron, and sodium were detected in all of the samples including the background location. The background concentrations were lower than those of the downstream locations. Cadmium, chromium, magnesium, manganese, and zinc were detected in the majority of the samples. The concentrations of cadmium, chromium, manganese, and zinc were all below 30 mg/kg. Magnesium ranged from 655 to 2970 mg/kg. Other less frequently detected metals included vanadium, copper, and calcium. Mercury was not detected in any sample (ESE, 1991).

2.4.5.5 Tissue Sampling

Fish tissue sampling was attempted during two days in January 1991, at periods of high and low tide. Two seine hauls were pulled through a small area of the site; however, no fish or shellfish were caught. Observations of the entire sampling area revealed that shellfish were not present along the shore or within the channel. This may have been due to the season in which the sampling was conducted (winter). The bottom of the channel was comprised of silty material, which may not provide a suitable substrate for the shellfish to survive (ESE, 1991).

2.5 Site 69 - Rifle Range Chemical Dump

This section provides an overview of the physical setting and features for Site 69.

2.5.1 Site Location and Setting

Site 69, The Rifle Range Chemical Dump, is located west of the New River estuary in the area of Camp Lejeune known as the Rifle Range (see Figure 2-1). The site is a former disposal grounds (landfill) and is approximately 6 acres in size. The site is heavily wooded with several species of trees including pine, dogwood, and oak. The understory is comprised of sparse grasses and shrubs (ESE, 1991). Access is restricted by a 6-foot high chain link fence with a locked entrance gate.

The site is located approximately three miles east-southeast of the intersection of Route 17 and Route 210 (see Figure 2-1). The site is situated where a light-duty (unnamed) roadway splits to form a "Y" (see Figure 2-7). This road shall be referred to in this Work Plan as the "access road".

The New River is located about one-quarter mile east of the site. Everett Creek is located about one-half mile south of the site. An unnamed tributary to the New River is situated about one-quarter mile north of the site. A light duty road borders the site to the west. Both Everett Creek and the unnamed tributary drain into the New River .

During the September 5, 1991 site reconnaissance, five areas of suspected disposal activities were observed. A brief description of these areas is presented below.

Two areas of stained soils were identified in the south-central portion of the site, as shown on Figure 2-7. Both areas were similar in appearance: dark brown, seeping soils. The first area (Stained Soil Area No. 1) is approximately 15 feet by 15 feet in area. The second stained area (Stained Soil Area No. 2) was smaller, and covered an area approximately 7 feet in diameter. The stains did not appear to be caused by a surface spill, instead they seemed to be caused from material that was buried underneath these areas. High readings on a metal detector were obtained at both of the stained areas. The areas immediately surrounding the two stained locations were covered with undisturbed vegetation and small trees. No particular odors were identified during the site visit.

Immediately north of Stained Soil Area No. 2, the Baker team identified what appeared to be a former disposal area. The disposal area appeared to be in an area approximately 1-to 2-feet wide by 20 feet long. Many glass vials, white powder material, and containers for chemical agent test kits were scattered along the ground surface in this area. The approximate location of this disposal area is identified on Figure 2-7.

Adjacent to this area, a long trench was observed. The size of the trench was approximately 75 feet long and 4 to 6 feet wide. The trench surface was covered with vegetation. Numerous mounds of soil were located along side the trench. Readings from the metal detector were elevated at these mounds. The approximate location of the trench is identified on Figure 2-7.

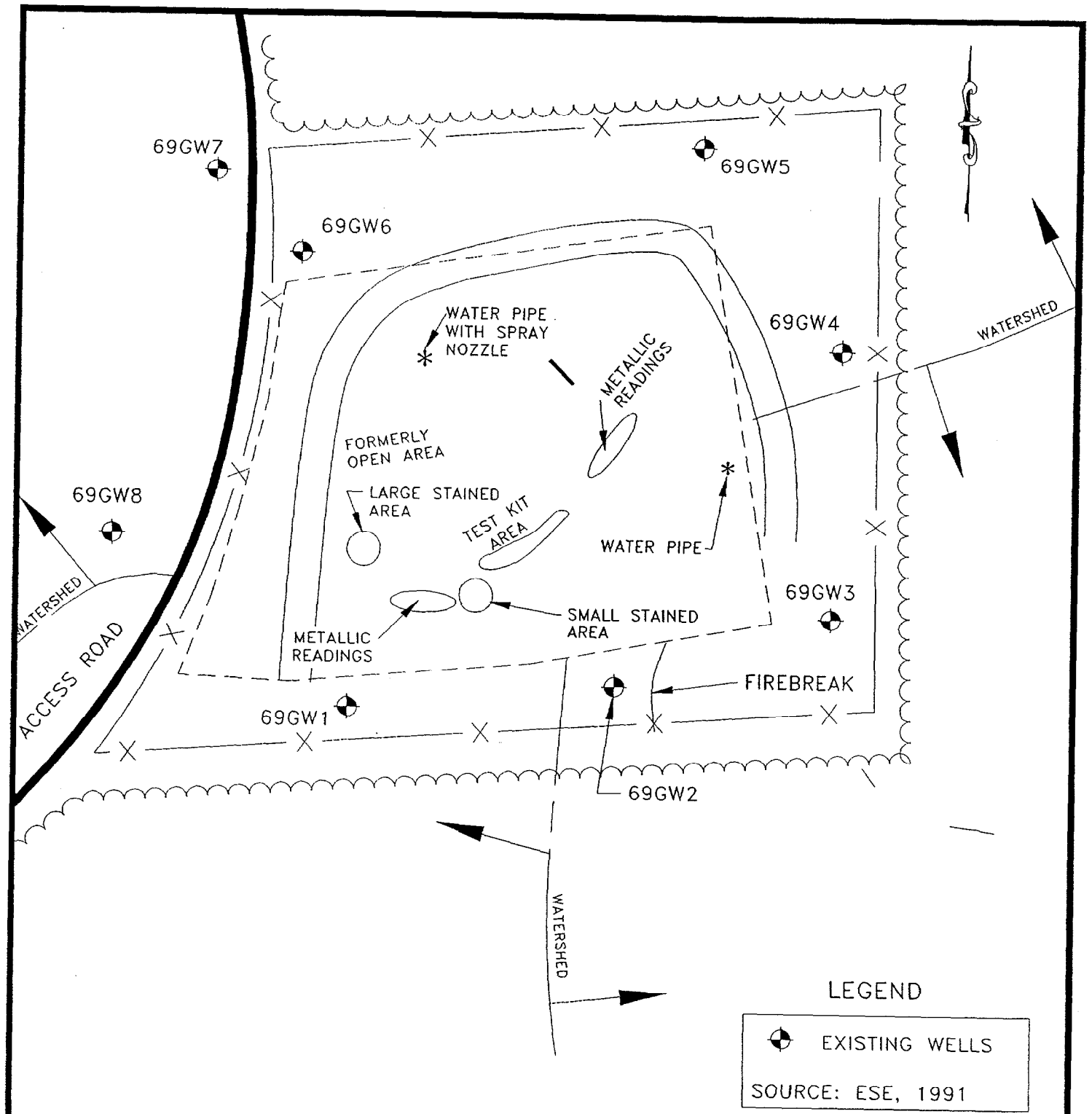


FIGURE 2-7
SITE 69
GENERAL ARRANGEMENT MAP
N.T.S.

In the northern-central portion of the site, an area evidently disturbed (referred to in this Work Plan as Area No. 3) was identified. This area is rectangular in shape and covers approximately 0.25 acre. It is evident that the area was formerly disturbed since the ground cover and trees presently consist of lawn vegetation and saplings. The vegetation immediately around the area is more dense and the trees are more mature. No other signs of contamination, such as staining or odors, were observed at Area No. 3.

2.5.2 Topography and Surface Drainage

Site 69 is situated at a topographic high for the immediate surrounding area. Most of the site within the fence is flat; however, the topography surrounding the site slopes gently in all directions (see Figure 2-7). During the September 1991 site reconnaissance, portions of the site area exhibited standing water, which could indicate poor drainage potential and may be indicative of a pocosin wetland.

Surface water runoff from the northern portion of the site may drain toward the unnamed tributary located to the north of the site; however, the area surrounding the site is heavily wooded and consists of a dense understory that could inhibit off-site drainage at great distances. Surface runoff from the southeastern portion of the site reportedly drains to unnamed ditches that drain into the New River. Surface runoff from the southwestern portion of the site drains into the Everett Creek basin, which could potentially drain into Everett Creek and the New River. However, as previously mentioned, the surrounding areas are heavily wooded and consist of a thick understory, which could inhibit overland surface runoff at great distances.

2.5.3 Site History

Site 69 was used as a chemical waste dump between 1950 and 1976. The waste materials were reportedly disposed in pits or trenches, 6 to 20 feet deep. Various wastes have been reportedly disposed at the site including: PCBs, fire retardants, pentachlorophenol, DDT, TCE, malathion, diazinon, lindane, calcium hypochlorite, gas cylinders, HTH, drums of "gas" [possibly training agent containing chloroacetophenone (CN)], chemical agent test kits for chemical warfare, and fired and unfired blank rifle cartridges (Water and Air Research, 1983).

Based on conversations with personnel from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) and the U.S. Army Technical Escort Unit, there is a high probability

that chemical agent training kits also are buried at the site, based on this historical information. PCBs were reportedly sealed in cement septic tanks prior to disposal at the site. The presence of the fired and unfired rifle cartridges indicate that troop training exercises may have occurred in this area at one time (Water and Air Research, 1983).

In 1970, an explosion reportedly occurred at Site 69 during a disposal operation. Containers of DDT, TCE, and calcium hypochlorite were placed in a pit at the site. While the containers were being covered with earthen material, an explosion and fire occurred, blowing some of the drums 40 yards away and starting a forest fire (Water and Air Research, 1983).

The site is inactive at present. Access is restricted by a chain-link fence.

2.5.4 Site Geology and Hydrogeology

Previous investigative activities at Site 69 involved the drilling of shallow well borings and the construction of eight monitoring wells in these borings. The site is reportedly underlain by silty sand and sandy clay with discontinuous layers of clayey sand, sand, sandy silt, and clayey silt (ESE, 1991). The water table was encountered in silty sand and clayey sand at depths ranging from approximately 5 to 22 feet below ground surface (bgs) in April 1987 and in silty sand, clayey sand, and sandy clay at depths ranging from approximately 7 to 27 feet bgs (ESE, 1991). Table 2-3 presents water level measurements from April 1987 and January 1991.

Groundwater flow may be impacted by watershed boundaries. Shallow groundwater flow is reported to be across the site towards the north and northwest (see Figure 2-7). Some mounding was reported in the vicinity of well 69GW1; however, it is believed to be localized (ESE, 1991). Groundwater gradients reportedly average 0.032 ft/ft.

2.5.5 Previous Investigations and Findings

This section summarizes the results of previous environmental investigations. A detailed description of the investigations, including tables, can be found in ESE's 1991 report that is referenced in this RI/FS Work Plan.

2.5.5.1 Soil Investigations

No soil samples have been collected at the Rifle Range Chemical Dump Site.

TABLE 2-3

SITE 69 GROUNDWATER ELEVATIONS AND WELL SPECIFICATIONS
MCB CAMP LEJEUNE, NORTH CAROLINA

Well No.(1)	Elevation TOC(2) (feet)	Elevation LS (feet)	Elevation Bottom of Screen(3) (feet)	Stick-Up (feet)	4/15/87		1/18 - 1/19/91	
					DTW - TOC (feet)	Elev - GW (feet)	DTW - TOC (feet)	Elev - GW (feet)
69GW1	94.11	91.64	70.60	2.44	4.92	89.19	12.54	81.57
69GW2	98.99	95.93	75.51	3.06	5.17	93.82	9.60	89.39
69GW3	97.01	95.21	74.86	1.80	5.63	91.38	7.21	89.80
69GW4	101.78	102.39	52.14	-0.61	6.92	94.86	9.25	92.53
69GW5	99.09	96.74	75.76	2.35	8.40	90.69	13.95	85.14
69GW6	92.54	90.70	60.17	1.84	22.08	70.46	26.80	65.74
69GW7	81.73	79.48	58.79	2.25	12.23	69.50	15.29	66.44
69GW8	100.00	97.70	77.3	2.30	8.50	91.50	8.32	91.68

Notes: TOC = Top of Casing
LS = Land Surface
DTW = Depth to Water
Elevations are relative to site only.

(1) All wells constructed of 2-inch PVC casing and Schedule 40 PVC screen.
(2) All measured elevations are relative to the site (e.g., the site is only 30 to 40 feet above msl but the reported elevation is higher than the actual elevation.)
(3) All well screen bottoms were constructed 20 feet below ground surface. Screen lengths are approximately 15 feet.
Source: ESE, 1991.

2.5.5.2 Groundwater Sampling

As part of the Verification Step conducted in July 1984, eight groundwater monitoring wells were installed and sampled at Site 69. The samples were analyzed for PCBs, pentachlorophenol, residual chlorine, organochlorine pesticides, mercury and VOCs (ESE, 1991). PCBs, pentachlorophenol, and chlorine were not detected in the samples. Mercury was detected but at levels significantly lower than the North Carolina Groundwater Standard of 1.1 µg/l. The majority of the samples, however, contained low concentrations of VOCs such as benzene, 1,2-dichloroethane, trans-1,2-dichloroethene, trichloroethene, toluene, and vinyl chloride.

In December 1986, a second round of groundwater samples was collected from the eight monitoring wells. This sampling was conducted by ESE as part of the Characterization Step. The samples were analyzed for the same compounds as in the 1984 sampling round plus tetrachlorodioxin, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), and ethylene dibromide (ESE,1991). The results from this sampling were similar to those of the 1984 sampling: various VOCs were detected in all of the samples.

As part of the Supplemental Characterization Step, the eight monitoring wells were sampled in January 1991. The samples were analyzed for full TCL parameters (ESE, 1991). Pesticides and semivolatiles were not detected in the samples. As with the other rounds of sampling, various VOCs were detected: carbon disulfide, 1,2-DCE (11,000 µg/l maximum), TCE (67 µg/l maximum), vinyl chloride (36 µg/l maximum), and chlorobenzene (40 µg/l maximum). Detected inorganics included: aluminum, calcium, chromium, iron, lead, manganese, sodium, vanadium, and zinc.

2.5.5.3 Surface Water Sampling

During the Characterization Step in December 1986, three surface water samples were collected from three small water-filled depressions around Site 69. One depression was on site near the southern edge of the site; the second depression was immediately east of the site; and the third depression was north of the site (downgradient). The sampling locations are shown on Figure 2-8. The samples were analyzed for organochlorine pesticides, PCBs, pentachlorophenol, VOCs, mercury, residual chlorine, tetrachlorodioxin, MEK, MIBK, and ethylene dibromide (ESE,1991). Pentachlorophenol (10 µg/l maximum) and VOCs, such as

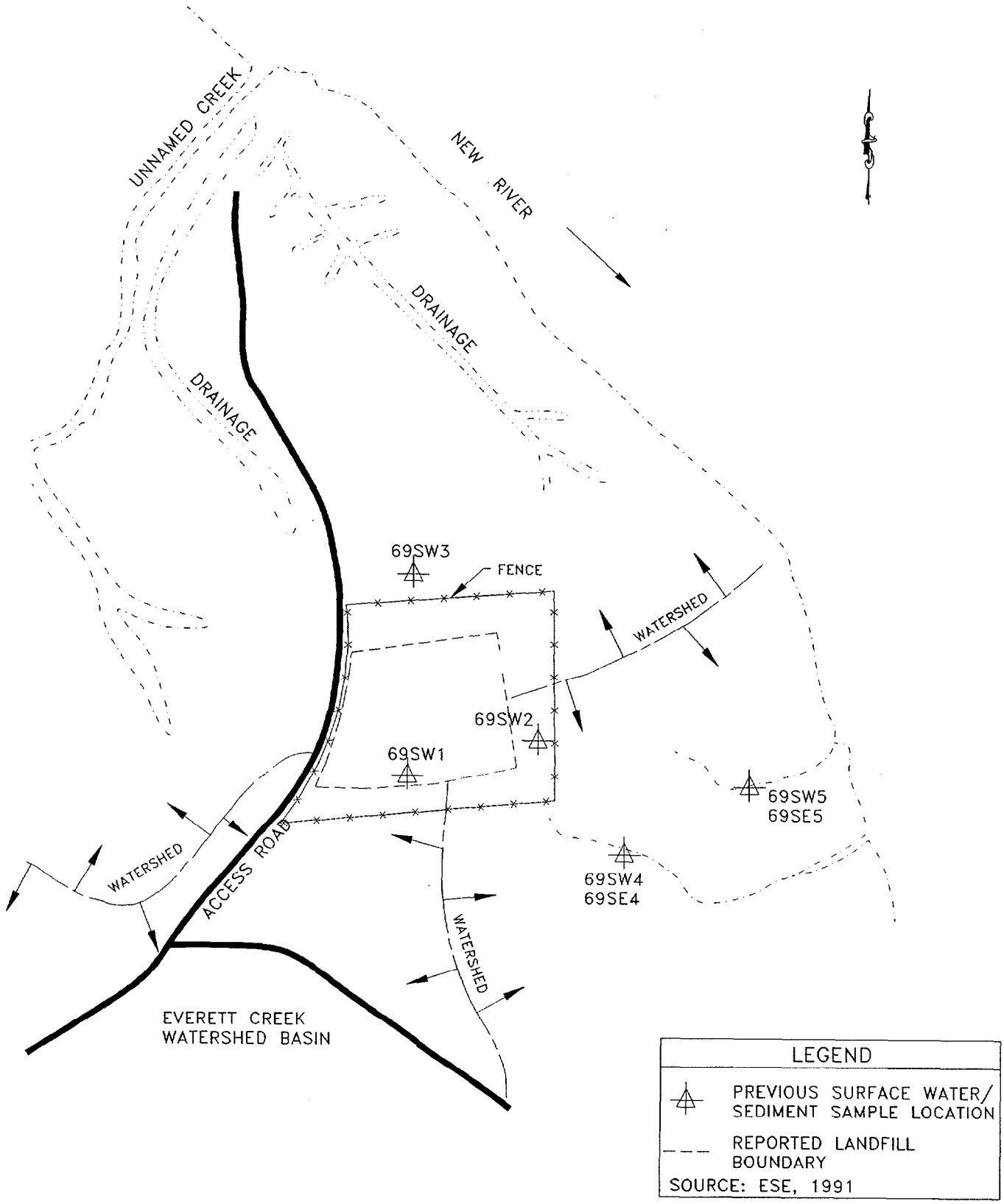


FIGURE 2-8
SITE 69
PREVIOUS SURFACE WATER/SEDIMENT SAMPLING LOCATIONS
RIFLE RANGE CHEMICAL DUMP

trans-1,2-DCE (410 µg/l maximum), TCE (63 µg/l maximum), and vinyl chloride (41 µg/l maximum), were detected in the on-site sample and the eastern sample. No VOCs were detected in the downgradient sample.

In January 1991, five surface water samples were collected around the site. One sample was collected at the same southern edge location that was sampled in 1986 (water-filled depression). The other four samples were collected in two unnamed tributaries that drain from the site into the New River estuary, east-southeast of the site. The samples were analyzed for full TCL parameters (ESE,1991). Pesticides and semivolatiles were not detected in the samples. VOCs were detected in the water-filled depression sample. No VOCs were detected in the other four samples. Inorganics detected in the samples included: aluminum, iron, magnesium, manganese, potassium, sodium, and zinc.

2.5.5.4 Sediment Sampling

As part of the Characterization Step conducted in December 1986, two sediment samples were collected from two unnamed tributaries that drain from Site 69 into the New River estuary. The two tributaries are located east-southeast of the site. The samples were analyzed for organochlorine pesticides, PCBs, pentachlorophenol, VOCs, mercury, residual chlorine, tetrachlorodioxin, MEK, MIBK, and ethylene dibromide (ESE, 1991). The only compounds detected in these samples included: DDD,pp' (0.113 µg/g), DDE,pp' (0.0188 µg/g), and pentachlorophenol (1.190 µg/g).

In January 1991, five sediment samples were collected at the same locations that were sampled in December, 1986. The samples were analyzed for full TCL parameters (ESE, 1991). No VOCs, pesticides and semivolatiles were detected in the samples. Inorganics detected in the samples included: aluminum, cadmium, chromium, iron, lead, manganese, sodium, and zinc.

2.5.5,.5 Tissue Sampling

Fish tissue sampling was performed in January 1991 in the New River estuary. The area was shallow with an average depth of two feet. Due to the lack of fish activity, shellfish (oysters and mussels) were collected and composited to form four samples. The samples were analyzed for full TCL parameters (ESE, 1991). Semivolatiles and pesticides were not detected in any of the samples. The only VOCs detected include chloromethane and acetone: chloromethane was

detected in all four samples at concentrations ranging from 17 to 210 µg/kg; acetone was detected in only one sample at a concentration of 28,000 µg/kg. Inorganics detected in all four samples included: aluminum, arsenic, calcium, chromium, copper, iron, magnesium, manganese, nickel, potassium, selenium, silver, sodium, vanadium, and zinc.

3.0 EVALUATION OF EXISTING INFORMATION

This section describes the types and volume of known wastes at each site, potential migration and exposure pathways, preliminary ARARs applicable to the sites, potential remedial technologies, and data limitations. This summary of information will be used to identify the RI/FS objectives (Section 4.0).

3.1 Site 6 - Lot 201

3.1.1 Types and Volumes of Waste Present

Only limited information is available on the former disposal activities conducted at Lot 201. Based on the results of the previous sampling events conducted at this site, it appears that soils, sediments and groundwater are the contaminated mediums. The contaminants found in the soil and sediments are the pesticides DDD, DDE and DDT. Upstream sediments in Bear Head Creek have higher concentrations of these pesticides than the downstream sediments. It is not known at this time if there are any pesticide sources upstream from Lot 201. Carbon disulfide, chloromethane and several metals were detected in the groundwater. No contaminants were detected in the surface water. In general, further evaluation is needed to determine the extent of soil, groundwater, sediment, and surface water (if any) contamination at Lot 201.

Since the location of the 10 soil samples was not documented in the reports reviewed for this Work Plan, an estimation of the vertical and horizontal extent of soil contamination can not be made. Therefore, the volume of waste present at the site can not be estimated. Existing information only states that pesticides and PCBs were stored at this lot.

3.1.2 Potential Exposure Pathways

Based on the evaluation of existing conditions at Site 6, Lot 201, the following potential contaminant exposure pathways have been identified:

- Aquatic and terrestrial wildlife exposure to pesticides due to incidental sediment and soil ingestion.

- Terrestrial wildlife (e.g., burrowing animals) dermal exposure to contaminants in soil and sediment.

- Human exposure to contaminants due to incidental soil and sediment ingestion.

- Potential human exposure to VOCs and metals from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply).

- Potential human exposure to VOCs due to volatilization from groundwater.

- Human dermal exposure to VOCs and metals due future potential direct contact with groundwater.

- Human exposure to pesticides and other contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife.

3.1.3 Preliminary Public Health and Environmental Health Impacts

A preliminary risk evaluation of Lot 201 has concluded that there may be potential human and ecological risk to receptors due to the contamination detected at this site. Military personnel and trespassers have been identified as the probable human receptors. The non-human population of receptors includes but is not limited to, small mammals such as raccoon and fox, deer, birds, reptiles and aquatic organisms such as fish.

3.1.4 Preliminary Identification of ARARs

ARARs are "applicable or relevant and appropriate requirements." Under Section 121(d)(1) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as reauthorized in 1986, remedial actions must attain a degree of cleanup which assures protection of human health and the environment. In addition, CERCLA remedial actions that leave any hazardous substance, pollutant, or contaminant on site must meet, upon completion of the remedial action, a level or standard of control that at least attains ARARs.

ARARs are derived from both Federal and State laws. There are three types of ARARs: chemical-specific, location-specific, and action-specific. Each of these ARAR types are discussed below with respect to Lot 201.

3.1.4.1 Chemical-Specific ARARs

Chemical-specific ARARs set limits on concentrations of specific hazardous substances, pollutants, and contaminants in the environment. Chemical-specific ARARs that may be applicable to Lot 201 include the North Carolina Water Quality Standards (NCWQS), the North Carolina Surface Water Standards, the Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act and the Federal Ambient Water Quality Criteria (AWQC) pursuant to the Clean Water Act. There are no North Carolina or Federal ARARs soil or sediment standards. However, EPA Region IV's "Water Quality and Sediment Screening Values" will be used as a To Be Considered (TBC) ARAR when evaluating ecological impacts in surface waters and sediment. The analytical methods and the level of Quality Assurance/Quality Control (QA/QC) used were not included in the background information received for this site.

Table 3-1 compares the maximum concentrations of compounds detected in the groundwater at Lot 201 with the NCWQS and the Federal MCLs. As shown on the table, constituents that exceed the established standards include barium, beryllium, chromium, iron, lead, and manganese. As shown on Table 3-2, no analyzed compounds exceed the North Carolina surface water standards, but trans-1,2-dichloroethene, trichloroethene, silver and zinc exceed the AWQC.

3.1.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of remedial activities in wetlands, floodplains, and historical sites. Location-specific ARARs for Lot 201 may include wetland and floodplain restrictions.

3.1.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration. Action-specific ARARs for Lot 201 will not be identified until potential remedial action technologies have been identified.

TABLE 3-1

COMPARISON OF POTENTIAL CHEMICAL-SPECIFIC ARARs WITH CONTAMINANTS DETECTED IN GROUNDWATER

CHEMICAL	North Carolina WQS[2] (µg/l)	Federal Primary MCLs[3] (µg/l)	Maximum Concentrations Detected in Groundwater Samples (µg/l)[4]		
			Site 6	Site 9	Site 69
VOLATILES:					
Acetone	NS	NS	12	ND	15
Benzene	1	5	3.1	ND	4
Carbon Disulfide	NS	NS	10	ND	9
Chlorobenzene	300	100	ND	ND	55
Chloroform	.19	NS	ND	ND	14
Chloromethane	NS	NS	6.5	ND	16
1,2-Dibromoethane	NS	NS	ND	.157	4.74
1,2-Dichloroethane	.38	5	ND	ND	5.9
1,1-Dichloroethylene	7	7	ND	ND	2.7
1,2-Dichloroethene	NS	NS	75	ND	220
Methylene Chloride	5	5[5]	ND	ND	10
1,1,2,2-Tetrachloroethane	NS	NS	63	ND	44
Tetrachloroethene	.7	5	53	ND	20
Toluene	1000	1000	ND	ND	14
trans-1,2-Dichloroethene	70	100	ND	ND	37000
Trichloroethene	2.8	5	13	ND	710
Vinyl Chloride	.015	2	70	ND	440
SEMIVOLATILES:					
Phenols	NS	NS	ND	6	ND
PESTICIDES:					
alpha-BHC	NS	NS	ND	ND	1.2
beta-BHC	NS	NS	ND	ND	.067
beta-BHC	NS	NS	ND	ND	2.44

TABLE 3-1 (Continued)

COMPARISON OF POTENTIAL CHEMICAL-SPECIFIC ARARs WITH CONTAMINANTS DETECTED IN GROUNDWATER

Chemical	North Carolina WQS[2] (µg/l)	Federal Primary MCLs[3] (µg/l)	Maximum Concentrations Detected in Groundwater Samples (µg/l)[4]		
			Site 6	Site 9	Site 69
INORGANICS:					
Arsenic	50	50	21.4	ND	11.4
Barium	1000	2000	1030	ND	ND
Beryllium	NS	1[5]	6.1	ND	ND
Cadmium	5	5	43.4	ND	ND
Chromium	50	100	451	86	47.6
Copper	1000	1300[6]	203	ND	27.5
Iron	300	NS	59300	ND	792000
Lead	50	15[6]	70.4	94	23.9
Magnesium	NS	NS	12900	ND	ND
Manganese	50	NS	1089	ND	230
Mercury	1.1	2	.32	ND	.2
Nickel	150	100[5]	81.6	ND	ND
Silver	50	50[7]	ND	ND	13.9
Zinc	5000	NS	9540	ND	10200
Cyanide	154	200[5]	ND	ND	11.2
Oil & Grease	NS	NS	NA	3	NA

(1) Abbreviations:
NS = No standard established.
ND = Not detected. Analytical method and QA/QC level was not provided in data provided for this evaluation.
NA = Not analyzed.
NCWQS = North Carolina Water Quality Standards.

(2) NCWQS. North Carolina Administrative Code, Title 15, NCDEHNR, Subchapter 2L, Section .0202 - Water Quality Standards for Groundwater, August 4, 1989. Class GA standards.

(3) Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act of 1986.

(4) Maximum concentrations listed do not include concentrations detected in blanks, estimated concentrations, or those concentrations detected below the method detection limit. Groundwater sampling was not conducted at Site 48.

(5) Proposed MCL.

(6) MCL is Action Level for Public Water Supply Systems, effective 11/06/91.

(7) As of 07/20/92 silver will only have a secondary MCL of 100 mg/l.

TABLE 3-2

COMPARISON OF POTENTIAL CHEMICAL-SPECIFIC ARARs WITH CONTAMINANTS DETECTED IN SURFACE WATER SAMPLES(1)

Chemical	Surface(2) Water Standards (µg/l)	Ambient Water Quality Criteria(3) (µg/l)	Maximum Concentrations Detected in Surface Water Samples (µg/l)(4)			
			Site 6	Site 9	Site 48	Site 69
VOLATILES:						
Acetone	NS	NS	ND	NA	NA	22
Benzene	NS	7×10^{-4}	ND	NA	NA	0.4
Carbon Disulfide	NS	NS	ND	NA	NA	28
Chlorobenzene	NS	1.2×10^{-4}	ND	NA	NA	2.1
Chloroform	NS	NS	ND	NA	NA	6
1,2-Dichloroethane	NS	1.1	ND	NA	NA	0.9
1,2-Dichloroethene	NS	0.22	ND	NA	NA	190
Ethylbenzene	NS	4.3×10^{-4}	ND	NA	NA	3
Methylene Chloride	NS	NS	ND	NA	NA	8
1,1,2,2-Tetrachloroethane	NS	NS	ND	NA	NA	59
Toluene	NS	0.005	ND	NA	NA	11
trans-1,2-Dichloroethene	NS	0.22	35	NA	NA	410
trichloroethene	NS	0.002	26	NA	NA	63
Vinyl Chloride	NS	NS	3.6	NA	NA	41
SEMIVOLATILES:						
Pentachlorophenol	NS	7.9×10^{-6}	NA	NA	NA	10
PESTICIDES:						
alpha-BHC	NS	NS	ND	NA	NA	0.056
beta-BHC	NS	NS	ND	NA	NA	0.18
delta-BHC	NS	NS	ND	NA	NA	0.2

TABLE 3-2 (Continued)

COMPARISON OF POTENTIAL CHEMICAL-SPECIFIC ARARs WITH CONTAMINANTS DETECTED IN SURFACE WATER SAMPLES(1)

Chemical	Surface(2) Water Standards (µg/l)	Ambient Water Quality Criteria(3) (µg/l)	Maximum Concentrations Detected in Surface Water Samples (µg/l)(4)			
			Site 6	Site 9	Site 48	Site 69
INORGANICS:						
Iron	NS	NS	365	NA	2060	4420
Magnesium	NS	NS	32600	NA	412000	753000
Manganese	NS	NS	NA	NA	57.7	223
Mercury	0.025	2.5×10^{-8}	NA	NA	ND	0.2
Silver	0.1(5)	2.3×10^{-6}	18.1	NA	39	ND
Zinc	86(5)	8.6×10^{-5}	45.8	NA	29.7	1960
Cyanide	1	1×10^{-6}	NA	NA	ND	11.2

(1) Abbreviations:
NS = No standard established.
ND = Not detected. Analytical method and QA/QC level was not provided in data provided for this evaluation.
NA = Not analyzed.

(2) North Carolina Administrative Code, Title 15, NCDEHNR, Subchapter 2B, Section .0212 - Tidal Salt Water Classifications and Standards. December 12, 1989. Class SC waters.

(3) Ambient Water Quality Criteria pursuant to the Clean Water Act.

(4) Maximum concentrations listed do not include concentrations detected in blanks, estimated concentrations, or those concentrations detected below the method detection limit.

(5) Action level.

3.1.5 Potential Remedial Technologies and Alternatives

The purpose of this section is to identify potential remedial technologies for each affected medium in order to identify what data may be necessary to better evaluate the technologies during the Feasibility Study.

3.1.5.1 Soil and Sediment

Previous investigative studies have identified the presence of pesticide residuals in surface soil and sediment samples (Bear Head Creek). Several technologies potentially capable of treating pesticides include thermal destruction (incineration), chemical extraction, dechlorination, stabilization/fixation, biodegradation, low temperature thermal treatment, and vacuum extraction. These technologies have been preliminarily identified as potentially feasible, based on the limited amount of information available for Lot 201. This listing will be refined as the RI progresses.

Each of the potentially feasible technologies will require specific data needs in order to evaluate their effectiveness, implementability, and cost. The review of existing background information did identify three areas within Lot 201 where pesticides and PCBs were stored. Data should be collected from these areas to assess remedial technologies.

3.1.5.2 Groundwater

Samples collected from monitoring wells did not exhibit organic contamination with the exception of one well with low levels of chloromethane and carbon disulfide. Inorganics were detected in some wells above State or Federal standards. The source of these constituents are unknown and will be reassessed during this RI/FS. Technologies associated with reducing metals will be considered.

3.1.5.3 Surface Water

Surface water samples collected during previous investigations did not exhibit either pesticide or volatile organic contamination. No technologies have been identified for surface water at this time. However, this will be reviewed upon evaluation of surface water data collected during this RI/FS.

3.1.6 Data Limitations

The purpose of this section is to define data limitations with respect to either characterizing the site, assessing health and environmental risks, or evaluating potential feasible technologies. The analytical methods and the level of Quality Assurance/Quality Control used for the analyses of the data provided for review were not included in the background information received for this site, and therefore could not be reported in this Work Plan. Consequently, the data provided is not suitable for use to fully characterize the site or to make an assessment of human health or ecological risks due to the contamination at Site 6, Lot 201. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Section 4 of this RI/FS Work Plan.

3.1.6.1 Soil

A limited amount of data has been collected from Lot 201. These data, which indicate the presence of pesticide residuals, is only representative of the top 3 feet of soil. In addition, the locations of previous sampling efforts are unknown, as well as the level of QA/QC and overall data quality. Based on the review of existing information, data will be required to characterize soil contamination, delineate areas of concern, assess human health and ecological risks, evaluate the extent of soil runoff towards Bear Head Creek, and evaluate potential remedial technologies.

3.1.6.2 Groundwater

Previous sampling efforts have not detected the presence of pesticides in groundwater. All but one monitoring well (6GW7) is located upgradient from the site; therefore, if a plume of contaminated groundwater is present, it may not have been detected by the present configuration of wells. In addition, the quality of existing groundwater data is unknown. Therefore, additional analytical data is required in order to fully characterize groundwater contamination, delineate plumes, assess human health and ecological risks, and evaluate remedial technologies.

3.1.6.3 Sediment

Previous sampling efforts along Bear Head Creek have detected the presence of pesticides in sediment upgradient and adjacent to the site. It is not known whether the sediment

contamination is due to site-related activities or other activities such as routine spraying along roadways for weed or insect control, or if there may be a source upstream of Lot 201. In order to evaluate the source and extent of contamination and human health and ecological risks, data would need to be collected from both banks of the stream, and at additional locations upgradient, adjacent, and downgradient of Lot 201.

3.1.6.4 Surface Water

Samples collected previously from Bear Head Creek did not detect the presence of any contaminants including pesticides in surface water. Because only two samples were collected along the entire stretch of the creek, and because the overall quality of this data is unknown, insufficient data are available to assess surface water quality and human health and ecological risks in Bear Head Creek.

3.1.6.5 Aquatic Life

Bear Head Creek is utilized as a recreational fishery downstream of Lot 201. Because pesticides were detected in the sediment and can potentially bioaccumulate, without specific analysis of residual organisms, data are not available to assess the potential impact to aquatic life, or bioaccumulation through the food chain.

3.2 Site 6 - Lot 203 and Wooded Areas

3.2.1 Types and Volumes of Waste Present

Based on the analytical results from previous investigations, elevated levels of VOCs and inorganics appear to be present in the groundwater and surface water at the site. Soils are contaminated with DDD, DDE, and DDT. In addition, several semivolatiles and inorganics were found to be present in sediments collected from Wallace Creek.

As previously discussed in Section 2.2, several disposal/storage areas were observed at Lot 203 during Baker's site reconnaissance. An assessment of the type and volume of waste present at each of these areas is presented below. Refer to Figure 2-5 for the location of these areas. Please note that the areas containing potentially live military ordnance (e.g. rockets, M-16 shells, artillery casings, ammunition boxes, and mine field clearing training kits), which are

identified on Figure 2-5, are not addressed below since they are not included in the scope of work for this Work Plan.

3.2.1.1 Drum Area No. 1

The first of several drum areas (Drum Area No. 1) was identified in the central portion of the site. The drum area, measuring 40 feet by 45 feet, contains nine overpacked drums and nine 55-gallon drums. The overpacked drums are labeled as hazardous waste but do not contain a date or identification of the waste type. The other nine drums are full but unlabeled. All of the drums are on pallets. No evidence of leakage was observed in this area. Remnants of a tarpaulin base were identified.

3.2.1.2 Drum Area No. 2

Drum Area No. 2 was identified in the central-southeastern portion of the site. This area, covering approximately 0.25 acre, contains three full drums and 42 empty drums. One of the full drums is labeled as containing tricresyl phosphate, a potential paralyzing agent. The other two full drums were located together on pallets and are labeled as containing lubricant oils. The empty drums, labeled as diesel fuel oil, were located in three small groupings within the drum area. Several of these drums are on their sides.

3.2.1.3 Drum Area No. 3

Drum Area No. 3 was identified in the southwestern corner of the site, near the office trailer. This area contains seven 55-gallon drums labeled "kerosene," two 55-gallon drums labeled "lube oil," and 31 empty bleaching powder cans. All of the drums are either empty or appear to be filled with rainwater.

3.2.1.4 Metal Debris Pile

A large pile of debris was identified in the southeast portion of the site, just outside the wooded area. The pile was observed to contain barbed wire, fencing, styrofoam boxes, and pallets. The pile is approximately 50 feet wide by 130 feet long by 18 feet high. No stressed vegetation was observed at this area.

3.2.1.5 Soil Mound

Immediately west of the Metal Debris Pile, a large mound of soil was identified. The mound is approximately 10 feet wide by 30 feet long by 10 feet high. The mound is covered with vegetation which did not appear to be stressed.

3.2.1.6 Electrical Transformer

One electrical transformer was identified in the central portion of the site. The transformer has a blue label stating that it contains less than 50 ppm PCBs. A test date (9-6-88) was also identified on the transformer. No other transformers were observed on the site.

3.2.1.7 Metal Cleaning Solution Disposal Area

Three crates containing several cases of metal cleaning solution were identified east of the transformer. Baker personnel estimated that there were approximately 350 to 400 individual cans of the cleaning solution. The cans are full, labeled, and the size of a small container of charcoal lighter fluid. The cans are rusted but did not appear to be leaking.

3.2.1.8 Sump

A sump was identified at the center of the site near the light pole Number 4. The sump was dry at the time of the site visit. No stained soils were observed in or near the sump. No stressed vegetation was observed. The sump appears to be aligned with the concrete culvert located approximately 100 yards to the north at the head of the unnamed tributary to Wallace Creek.

3.2.1.9 PCB and DDT Dump/Spill Area

A small area (approximately 0.25 acre) in the northeast corner of the site previously was used as a storage area for PCBs. In addition, DDT disposal reportedly occurred in the southeast corner of this lot. During Baker's site visit, no signs of spilled material or stressed vegetation were observed. The existing vegetative cover consists of thick grasses.

The site reports reviewed for this Work Plan indicate that the amount and extent of DDT disposal at Lot 203 may be several hundred pounds within an area of an 80 to 100-foot radius.

In addition, the amount of DDT spilled on the site could be approximately 100 to 200 pounds (Water and Air Research, 1983).

3.2.1.10 Trailer Area

In the immediate area around the on-site office trailer (located in the southwest corner of the site), five empty drums were identified. The empty drums are labeled as formerly containing either TCE or lubricant oil. Stained soil, approximately 4 feet long by 3 feet wide, was observed next to one of the drums.

3.2.1.11 Fiberglass-Type Hose Material Pile

East of the trailer area, a pile of white fiberglass-type hose material was identified during the site visit. The pile is estimated to be approximately three feet wide by seven feet long by one foot high. Upon observation of photographs of this material by Baker personnel, this material does not appear to contain asbestos.

3.2.1.12 Rubber-Cleated Tread Pile

A large pile of discarded rubber-cleated treads used for military vehicles was observed in the north-central part of the site. The pile measures approximately 75 feet wide by 100 feet long by 20 feet high.

3.2.1.13 500-Gallon Above Ground Storage Tank

A 500-gallon, steel aboveground storage tank was identified in an area directly north of the office trailer, along the western edge of the site. The tank is labeled as containing diesel fuel. The tank is supported above the ground surface in a horizontal position by a metal support stand. The area around the tank appears discolored.

3.2.1.14 250-Gallon Above Ground Storage Tanks

Three 250-gallon above ground storage tanks were identified immediately north of the 500-gallon above ground tank. These tanks are positioned side-by-side on a horizontal support stand. The tanks are labeled as containing either diesel, gasoline, or kerosene fuels. The tanks are rusted but did not appear to be leaking.

3.2.1.15 Empty Fenced-In Area

Adjacent to and north of the 250-gallon tanks, an empty fenced-in area was identified. The size of the area is approximately 20 feet by 40 feet. The soils in the area are very spongy. No visible evidence of past disposal/storage activities was observed.

3.2.1.16 Acid Storage Area

A fenced-in storage area was identified in the northwest portion of the site (northeast of the Empty Fenced-In Area). A sign stating "Caution - Acid, Handle With Care" is posted outside the fence near the gate. Therefore, it is assumed that acids have previously been stored here. The area, which measures approximately 20 feet by 40 feet, includes two small, enclosed shelters and a roofed, open-sided storage shed. One of the enclosed shelter contains office-type equipment. The other enclosed shelter contains hoses and two 50-pound cylinder containers of DuPont-type freon. The roofed storage shed has a plastic sheeting floor. Several empty drums are located in the roofed shed and also in other parts of the Acid Storage Area. An unlabeled compressed gas cylinder and two storage crates were identified elsewhere within the Acid Storage Area. The vegetation and soils within the storage area are similar to the rest of the site. No visible signs of contamination were observed.

3.2.1.17 Metal Debris Storage Stalls

Immediately adjacent to the Acid Storage Area and along the northern site boundary fence, two storage area stalls were identified. The size of each stall is approximately 12 feet by 18 feet. Broken electric motor parts and fans are scattered throughout one of the stalls. The second stall is littered with broken radio parts, circuit boards, and small batteries. No other visible signs of contamination were noted in these storage areas.

3.2.1.18 "Corrosive" Drum Area

Twelve empty, plastic drums were identified in an area located to the east of the Metal Debris Storage Stalls. The drums, labeled as containing corrosives, are grouped together in a small area. Several of the drums are lying on their side. Anti-tank rockets, M-16 cartridge casings, and mine field clearing training kits were identified in close proximity to this drum storage area.

3.2.1.19 Shredded Tire Piles

Two piles of shredded tires were identified at the site. One pile is located in the south-central area of the site. The other pile is located towards the wooded area in the eastern one-third of the site, in between the Metal Cleaning Solution Disposal Area and Drum Area No. 2. No visible signs of contamination were observed at either tire area.

3.2.1.20 Ravine Area

Evidence of past disposal activities was identified throughout the ravine area. Immediately downstream of the concrete culvert, items such as commodes, empty drums, steel fragments, and old cabinets were identified along both embankments of the ravine. All of the unidentified empty drums are rusted.

Approximately 1000 feet upstream from the confluence of Wallace Creek and the Ravine, a small disposal area for old batteries and wire cable was identified. It appears that after the batteries were dumped on the ravine embankment, many of them fell into a small pool of standing water below. The pool of water is approximately 2 to 5 feet wide, 7 feet long, and 2 feet deep at the time of the reconnaissance. No visible signs of contamination were observed in the water or the soils in this area.

In the same general vicinity of the battery, disposal area, several commercial-type ovens (with what appears to be) asbestos insulation were identified.

Further downstream, areas of old tires, small metal cans, and plastic canisters were identified. Upon further observation, the metal cans were identified as containers for plastic full-face respirator cartridges.

3.2.2 Potential Exposure Pathways

Based on the evaluation of existing conditions at Site 6, Lot 203, the following potential contaminant exposure pathways have been identified:

- Aquatic and terrestrial wildlife exposure to VOCs and metals due to surface water ingestion.

- Aquatic and terrestrial wildlife exposure to pesticides due to incidental soil ingestion.

- Aquatic and terrestrial wildlife exposure to semivolatiles and inorganics due to incidental sediment ingestion.

- Terrestrial wildlife (e.g., burrowing animals) dermal exposure to pesticides in soil and sediment.

- Human exposure to pesticides due to incidental soil ingestion.

- Human exposure to semivolatiles and inorganics due to incidental sediment ingestion.

- Human exposure to VOCs and metals due to future potential groundwater ingestion.

- Human exposure to VOCs due to volatilization from groundwater and surface waters.

- Human dermal exposure to VOCs and metals due to future potential direct contact with groundwater and direct contact with surface waters.

- Human exposure to VOCs, semivolatiles, metals and pesticides due to ingestion of contaminated aquatic organisms and terrestrial wildlife.

3.2.3 Preliminary Public Health and Environmental Health Impacts

A preliminary risk evaluation of Site 6 (Lot 203 and wooded areas) has concluded that there may be potential human and ecological risk to receptors due to the contamination detected at this site. Military personnel and trespassers have been identified as the probable human receptors. The non-human population of receptors includes but is not limited to, small mammals such as raccoon and fox, deer, birds, reptiles and aquatic organisms such as fish.

3.2.4 Preliminary Identification of ARARs

3.2.4.1 Chemical-Specific ARARs

Based on the analytical results from the previous sampling activities conducted for Lot 203, it appears that the contaminated media include soils (pesticides), groundwater (VOCs and various inorganics), surface water (VOCs and various inorganics), and sediments (possibly semivolatiles). Chemical-specific ARARs that may be applicable to Lot 203 include the NCWQS, the North Carolina Surface Water Standards, and the Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act and AWQC. There are no North Carolina or Federal ARARs soil or sediment standards; however, EPA Region IV's "Water Quality and Sediment Screening Values" will be used as a TBC ARAR when evaluating ecological impacts in surface waters and sediment in the risk assessment.

Table 3-1 compares the maximum concentrations of compounds detected in the groundwater at Lot 203 with the NCWQS and the Federal MCLs. As shown on the table, compounds that exceed the established standards include benzene, tetrachloroethene, TCE, vinyl chloride, beryllium, cadmium, chromium, iron, lead, manganese, and zinc. As shown on Table 3-2, maximum detected silver concentrations exceed the North Carolina surface water standards.

3.2.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of activities in wetlands, floodplains, and historical sites. Location-specific ARARs for Lot 203, near Wallace Creek, may include wetland and floodplain restrictions.

3.2.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration. Action-specific ARARs for Lot 203 will not be identified until potential remedial action technologies have been identified.

3.2.5 Potential Remedial Technologies and Alternatives

The purpose of this section is to identify potential remedial technologies for each affected medium in order to identify what data may be necessary to better evaluate the technologies during the Feasibility Study.

3.2.5.1 Soil

Previous investigative studies have identified the presence of pesticide residuals in surface soil samples, and the disposal of pesticides and PCB storage. In addition, the groundwater is contaminated with volatiles. Although the lot and wooded areas need extensive further characterization, a few remedial technologies have been identified for these areas based on the limited information. These technologies include: thermal treatment, solidification/fixation, soil washing, and biodegradation. Each of these technologies will require specific data to evaluate them more thoroughly.

3.2.5.2 Sediment

Previous investigative studies have identified the presence of low levels of semivolatiles and inorganic residuals in sediment samples (Wallace Creek). Several technologies potentially capable of treating semivolatiles include thermal destruction (incineration), chemical extraction, soil washing, stabilization/fixation, and biodegradation. Technologies applicable to treatment of inorganic-contaminated sediments, if necessary, include soil washing and stabilization. These technologies have been preliminarily identified as potentially feasible, based on the limited amount of information available. This listing will be refined as the RI/FS progresses.

Each of the potentially feasible technologies will require specific data in order to evaluate their effectiveness, implementability, and cost.

3.2.5.3 Groundwater

Previous investigations have detected the presence of volatile and inorganic compounds in the shallow aquifer. A number of technologies have been identified as potentially feasible including pumping, containment (via extraction wells), air stripping, chemical reduction, carbon adsorption, UV/ozone oxidation, and in-situ chemical treatment.

Because groundwater data primarily represent areas outside of Lot 203, a better characterization is needed to define on-site conditions and the extent of off-site contamination. However, data should be collected to assess physical/chemical treatment technologies.

3.2.5.4 Surface Water

Previous investigations have detected the presence of volatile organics in surface water both upgradient and adjacent to Lot 203. This contamination may be due either to the "Lot 203"groundwater plume discharging into Wallace Creek, or a second plume emanating from another location. Until the source of volatile organics in Wallace Creek can be better defined, a further evaluation of potential technologies should be delayed until additional surface water and groundwater data are collected.

3.2.6 Data Limitations

The purpose of this section is to define data limitations with respect either to characterizing the site, assessing health and environmental risks, or evaluating potential feasible technologies. The analytical methods and the level of Quality Assurance/Quality Control used for the analyses of the data provided for review were not included in the background information received for this site, and therefore could not be reported in this Work Plan. Consequently, the data provided is not suitable for use to fully characterize the site or to make an assessment of human health or ecological risks due to the contamination at Site 6, Lot 203. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Section 4 of this RI/FS Work Plan.

3.2.6.1 Drums

As noted in Section 2.2, numerous drums are present on the surface of Lot 203 and the wooded areas of the site. Additionally, there may be reason to believe that drums are also buried within Lot 203: a driller's log sheet indicates a local worker's statement that "a lot was buried under the site" (ESE, 1991). In some cases, the drums on the surface have markings with respect to their original contents. However, many of the drums do not. In summary, the contents of the drums on the surface of Lot 203 are unknown. Additionally, the presence of buried drums should be investigated with respect to location and content.

3.2.6.2 Soil

Based on the size of Lot 203 (46 acres) and the surrounding wooded area (approximately 150 acres), and the limited amount of soil data (10 surface soil samples), the existing soil database is limited to characterize the types of potential contamination within these areas. In addition, more data is required to adequately assess human health and ecological risks due to Lot 203 and the wooded portions of the site.

3.2.6.3 Groundwater

Existing data have confirmed the presence of volatile organic groundwater contamination along the northern border of Lot 203 in Wallace Creek. No data are available to determine the vertical or horizontal extent of contamination, or to determine what area of concern within Lot 203 or the wooded areas may be acting as a source of groundwater contamination. In addition, more data is required to adequately assess human health and ecological risks due to these areas.

3.2.6.4 Sediment

Existing data have confirmed the presence of semivolatiles and inorganics in the sediments of Wallace Creek. Additional analytical data will be needed in order to characterize sediment contamination, delineate areas of concern, and assess human health and ecological risks due to contaminated sediments at Lot 203.

3.2.6.5 Surface Water

VOCs and metals were detected in two surface water samples collected from Wallace Creek. In order to fully characterize the surface water quality and to assess human health and ecological risks, additional surface water samples will be required.

3.2.6.6 Aquatic Life

Wallace Creek is utilized as a recreational fishery at Camp Lejeune. Semivolatile and inorganic contaminants were detected in the sediment can bioaccumulate without specific analysis of resident organisms. Data are not available to assess the potential impact to

aquatic life. Additionally, no data are available to assess potential impacts to aquatic life from VOC-contaminated surface water.

3.3 Site 9 - Fire Fighting Training Pit

3.3.1 Types and Volumes of Waste Present

Site 9 has been used for fire fighting exercises from the 1960's to the present. Until 1981 the exercises were held in an unlined pit, which is now asphalt-lined. There are three above ground storage tanks located to the west of the training pit which contain the fuels used to create the fires. The fuels have not been identified but based on markings on the tanks, they are believed to contain the jet fuels, JP-4 and JP-5. Approximately 30,000 - 40,000 gallons per year of these fuels are reportedly used during the training exercises. Additional flammable liquids including oil, solvents and contaminated fuels (non-leaded) have also been burned in the pit. No information is available to determine if fire retardants were used to extinguish the fires.

An oil/water separator is located south of the pit. It is not known where the water is discharged to after it is separated from the fuel. The fate of the discharged water will need to be investigated during the RI/FS to determine if it is a source of contamination at Site 9.

Two previous investigations (July 1984 and November 1986/1987) of Site 9 focused on groundwater only. No soil, surface water or sediment investigations were conducted. Based on the analytical results of these two sampling periods chromium, lead, phenols, 1,2-dibromomethane and oil & grease are present in the groundwater at this site.

3.3.2 Potential Exposure Pathways

Based on the evaluation of the background information available for Site 9 and the identification of metals, semivolatiles and organics in the groundwater, the following potential exposure pathways have been identified:

- Aquatic and terrestrial wildlife ingestion exposure to metals, semivolatiles and VOCs due to the potential discharge of contaminated groundwater to surface waters.

- Human exposure to VOCs, semivolatiles and metals due to future potential groundwater ingestion.

- Human exposure to VOCs due to volatilization from groundwater and surface water.

- Human dermal exposure to VOCs, semivolatiles and metals due to future potential direct contact with groundwater and direct contact surface waters.

- Human exposure to VOCs, semivolatiles and metals due to ingestion of contaminated aquatic organisms and terrestrial wildlife.

3.3.3 Preliminary Public Health and Environmental Health Impacts

A preliminary risk evaluation of Site 9 has concluded that there may be potential human and ecological risk to receptors due to the contamination detected at this site. Military personnel and trespassers have been identified as the probable human receptors. The non-human population of receptors includes but is not limited to, small mammals such as raccoon and fox, deer, birds, reptiles and aquatic organisms such as fish.

3.3.4 Preliminary Identification of ARARs

3.3.4.1 Chemical-Specific ARARs

Based on the analytical results from the previous sampling activities conducted for Site 9, the only confirmed contaminated media at this site is groundwater; since surface water, sediments and soil were not sampled. However, surface water and sediments could be contaminated due to groundwater discharge to surface water. Soils could also be potentially contaminated due to the fire fighting activities occurring in the unlined pit. Therefore, the preliminary identification of ARARs applicable at Site 9 would include North Carolina Water Quality Standards for groundwater and surface water, Federal Maximum Contaminant Levels and Ambient Water Quality Criteria. There are no North Carolina or Federal soil or sediment standards that can be identified as potential ARARs at this time, however EPA Region IV's "Water Quality and Sediment Screening Values" will be used as a TBC ARAR when evaluating ecological impacts in surface water and sediment in the risk assessment.

3.3.4.2 Location-Specific ARARs

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations, e.g., wetlands, floodplains, historic places. The potential location-specific ARARs identified for Site 9 may include wetland and floodplain restrictions along Bear Head Creek.

3.3.4.3 Action-Specific ARARs

Action-specific ARARs are technology or activity-based restrictions or limitations on actions taken with respect to hazardous waste. They are triggered by the type of remedial activities that are selected to accomplish a remedy. Action-specific ARARs for Site 9 will not be identified until potential remedial action technologies have been identified.

3.3.5 Potential Remedial Technologies and Alternatives

The purpose of this section is to identify potential remedial technologies for each affected medium in order to identify what data may be necessary to evaluate technologies during the Feasibility Study.

3.3.5.1 Soil and Sediment

No soil or sediment sampling has been performed at this site. Since the fire fighting activities were conducted in an unlined pit for a number of years it is possible that soil contamination exists at Site 9. In addition, there could also be a potential for sediment contamination due to the discharge of groundwater into the surface water ultimately contaminating the sediments in the area. This situation will need to be assessed during the RI/FS following the acquisition of soil and sediment data. Potential remedial technologies for fuel-contaminated soil include bioremediation and thermal treatment.

3.3.5.2 Groundwater

Previous investigations have identified the presence of metals, oil & grease, volatiles and semivolatiles in the groundwater at Site 9. Since the parameters previously analyzed for were very limited, additional sampling will be required to fully assess Site 9 during the RI/FS.

Potential remedial technologies associated with this type of contamination include separation, chemical reduction, air stripping, carbon adsorption, and biodegradation.

3.3.5.3 Surface Water

No surface water samples have been taken at Site 9. Because it is possible that groundwater discharge could have potentially impacted the surface water of Bear Head Creek, the remediation of the surface water may be necessary. This situation will need to be assessed during the RI/FS following the acquisition of surface water data. Therefore, no remediation technologies are being considered for surface water at this time.

3.3.6 Data Limitations

The purpose of this section is to define limitations with respect to either characterizing the site, assessing health and environmental risks, or evaluating potential feasible technologies. The analytical methods and the level of Quality Assurance/Quality Control used for the analyses of the data provided for review were not included in the background information received for this site, and therefore could not be reported in this Work Plan. Consequently, the data provided is not suitable for use to fully characterize the site or to make an assessment of human health or ecological risks due to the contamination at Site 9. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Section 4 of this RI/FS Work Plan.

3.3.6.1 Soil

No soil data have been collected from Site 9. Analytical data will be required in order to characterize soil contamination, delineate areas of concern, assess human health and ecological risks, evaluate remedial technologies, and evaluate the extent of soil runoff towards Bear Head Creek at Site 9.

3.3.6.2 Groundwater

The two previous investigations (July 1984 and November 1986/January 1987) of Site 9 analyzed for limited parameters in the groundwater. The parameters analyzed for in 1984 included cadmium, chromium, lead, oil & grease, volatile organics and total phenols. During the 1986/1987 sampling round, the parameters included xylene, methyl ethyl ketone, methyl

isobutyl ketone, ethylene dibromide and hexavalent chromium. Additional analytical data will be required in order to fully characterize groundwater contamination, delineate plumes, evaluate potential technologies, and assess human health and ecological risks associated with Site 9.

3.3.6.3 Sediment

No sediment samples have been collected from Site 9. Analytical data will be required in order to characterize sediment contamination, delineate areas of concern and assess human health and ecological risks at Site 9.

3.3.6.4 Surface Water

No surface water samples have been collected from Site 9. Analytical data will be required in order to characterize surface water contamination and assess human health health and ecological risks at Site 9.

3.3.6.5 Aquatic-Life

Since no surface water or sediment analyses have been performed at Site 9, data are not available to assess the potential impact to aquatic-life associated with Site 9. After these data gaps are addressed in the RI/FS, an assessment of aquatic-life associated with Site 9 can be performed.

3.4 Site 48 - MCAS Mercury Dump

3.4.1 Types and Volumes of Waste Present

The site reports reviewed for this Work Plan indicate that metallic mercury was periodically disposed at the MCAS Mercury Dump (an area approximately 100 feet by 200 feet). The quantity of mercury disposed at this dump area is estimated to be one gallon per year over a 10 year period, totaling more than 1000 pounds (Water and Air Research, 1983).

Based on the results of the previous sampling events conducted at the site, it appears that mercury and other metals contamination is present in the soils and the sediments and silver and zinc are present in the surface water.

3.4.2 Potential Exposure Pathways

Based on the evaluation of the existing conditions at Site 48 the potential exposure pathways identified for Site 48 include the following:

- Aquatic and terrestrial wildlife exposure to metals due to surface water ingestion.
- Aquatic and terrestrial wildlife exposure to metals due to incidental soil and sediment ingestion.
- Terrestrial wildlife (e.g., burrowing animals) dermal exposure to metals in soil and sediment.
- Human exposure to metals due to incidental soil and sediment ingestion.
- Human dermal exposure to metals due to direct contact with surface waters.
- Human exposure to metals due to ingestion of contaminated aquatic organisms and terrestrial wildlife.

3.4.3 Preliminary Public Health and Environmental Health Impacts

A preliminary risk evaluation of Site 48 has concluded that there may be potential human and ecological risk to receptors due to the contamination detected at this site. Military personnel and trespassers have been identified as the probable human receptors. The non-human population of receptors includes but is not limited to, small mammals such as raccoon and fox, deer, birds, reptiles and aquatic organisms such as fish.

3.4.4 Preliminary Identification of ARARs

3.4.4.1 Chemical-Specific ARARs

Based on the analytical results from the previous sampling activities conducted for Site 48, it appears that the contaminated media include soils (mercury and other metals), and sediments (possibly mercury and other metals). Groundwater was not sampled at this site. Chemical-

specific ARARs that may be applicable to Site 48 include the North Carolina Surface Water Standards. There are no North Carolina or Federal ARARs soil or sediment standards; however, EPA Region IV's "Water Quality and Sediment Screening Values" will be used as a TBC ARAR when evaluating ecological impacts in surface waters and sediment.

Table 3-2 compares the maximum concentrations of compounds detected in the surface water at Site 48 with the North Carolina surface water standards. As shown on the table, silver is the only compound that exceeds the established state standards, while silver and zinc exceed the AWQC.

3.4.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of activities in wetlands, floodplains, and historical sites. Location-specific ARARs for Site 48 include wetland and floodplain restrictions.

3.4.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration. Action-specific ARARs for Site 48 will not be identified until potential remedial action technologies have been identified.

3.4.5 Potential Remedial Technologies

The purpose of this section is to identify potential remedial technologies for each affected medium in order to identify what data may be necessary to evaluate technologies during the Feasibility Study.

3.4.5.1 Soil and Sediment

Previous sampling investigations have detected mercury in both surface soil and sediment samples. Potential technologies for remediation of mercury in soil and sediment include stabilization/fixation, soil washing, and in-situ vitrification (soil only).

3.4.5.2 Groundwater

If groundwater is contaminated with inorganics (or organics due to some unknown source), technologies involving chemical precipitation can be employed. Data should be collected during the RI to assess physical or chemical reduction technologies.

3.4.5.3 Surface Water

Mercury was not detected in any of the surface water samples collected during previous investigations. No technologies are being considered at this time for remediation of surface water. Based on the results of this RI, the technologies required to remediate surface water will be reconsidered.

3.4.6 Data Limitations

The purpose of this section is to define data limitations with respect to either characterizing the site, assessing health and environmental risks, or evaluating potential feasible technologies. The analytical methods and the level of Quality Assurance/Quality Control used for the analyses of the data provided for review were not included in the background information received for this site, and therefore could not be reported in this Work Plan. Consequently, the data provided is not suitable for use to fully characterize the site or to make an assessment of human health or ecological risks due to the contamination at Site 48. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Section 4 of this RI/FS Work Plan.

3.4.6.1 Soil

A limited number of samples (five soil samples from four soil borings at a depth just above the water table) were collected from Site 48. Mercury was detected in all four samples. Because the exact location of where these samples were obtained is unknown, the vertical and horizontal extent of mercury contamination and the "source" area(s) have not been adequately defined. In addition, other metals such as cadmium and zinc have not been analyzed to date. Human health and ecological risks also need to be assessed. In addition, only inorganics have been analyzed; no organic data are available to fully evaluate risks or characterize the site.

3.4.6.2 Groundwater

No groundwater monitoring wells have been installed at the site. Groundwater quality needs to be defined to assess potential impacts to the New River and the future potential human health risks and ecological risks due to Site 48.

3.4.6.3 Sediment

Sediment samples collected from the Marsh area of the New River have exhibited mercury contamination. Samples collected along the bank near the site, however, did not exhibit the presence of mercury. The extent of mercury contaminated sediments, offshore and downstream along the shoreline needs to be assessed, and downstream data need to be obtained. In addition, potential human health and ecological risks need to be assessed due to sediment sampling.

3.4.6.4 Aquatic Life

Previous investigations attempted to collect shellfish for subsequent tissue analysis. No shellfish could be collected. This may have been due to the time of the year (the sampling was attempted during the winter). The impact, if any, to benthic as well as shellfish organisms is unknown. However, further evaluation of aquatic life may be necessary due to methyl mercury's high bioconcentration/bioaccumulation factors at very low levels in sediment and surface waters.

3.5 Site 69 - Rifle Range Chemical Dump

3.5.1 Types and Volumes of Waste Present

According to documented information in site reports approximately 93,000 cubic yards of hazardous material may have been disposed at Site 69, based on an area of approximately six acres and an assumed depth of 10 feet (Water and Air Research, 1983). The hazardous materials include pentachlorophenol, various pesticides (DDT, malathion, diazinon, lindane), TCE, PCBs, fire retardants, chemical agent test kits, gas cylinders, drums of "military chemical agents", and rifle cartridges. These materials, reportedly, were disposed in pits or trenches ranging from 6 feet to 20 feet deep (Water and Air Research, 1983). There have been no individual volume estimates made for each type of material disposed at the site.

As previously discussed in Section 2.4, several areas of suspected disposal activities were observed at Site 69 during Baker's site reconnaissance: two areas of stained soils, a chemical agent test kit disposal area, a long trench, and a formerly open area. The chemical agent test kits were the only items on the list of disposed materials that were observed during the September 1991 site reconnaissance.

Based on the analytical data collected from the site, VOCs and various inorganics are present in the groundwater and surface water at the site. Pesticides and pentachlorophenol may be contained in sediments. No soil sampling has been conducted in previous investigations.

3.5.2 Potential Exposure Pathways

Based on the evaluation of existing conditions at Site 69, the following potential contaminant exposure pathways have been identified:

- Aquatic and terrestrial wildlife exposure to VOCs and metals due to surface water ingestion.
- Aquatic and terrestrial wildlife exposure to pesticides and semivolatiles due to incidental sediment ingestion.
- Terrestrial wildlife (e.g., burrowing animals) dermal exposure to pesticides and semivolatiles in sediment.
- Human exposure to pesticides and semivolatiles due to incidental sediment ingestion.
- Human exposure to semivolatiles and pesticides due to incidental sediment ingestion.
- Human exposure to VOCs and metals due to future potential groundwater ingestion.
- Human exposure to VOCs due to volatilization from groundwater and surface waters.
- Human dermal exposure to VOCs and metals due to future potential direct contact with groundwater and contact with surface waters.

- Human exposure to VOCs, semivolatiles, metals and pesticides due to ingestion of contaminated aquatic organisms and terrestrial wildlife.

3.5.3 Preliminary Public Health and Environmental Health Impacts

A preliminary risk evaluation of Site 69 has concluded that there may be potential human and ecological risk to receptors due to the contamination detected at this site. Military personnel and trespassers have been identified as the probable human receptors. The non-human population of receptors includes but is not limited to, small mammals such as raccoon and fox, deer, birds, reptiles and aquatic organisms such as fish.

3.5.4 Preliminary Identification of ARARs

3.5.4.1 Chemical-Specific ARARs

Based on the analytical results from the previous sampling activities conducted for Site 69, it appears that the contaminated media include groundwater (VOCs and inorganics), surface water (VOCs and inorganics), sediments (pesticides, inorganics, and pentachlorophenol), and shell fish tissue (possible VOCs and inorganics). Possible chemical-specific ARARs related to the remediation of these contaminated media may include: NCWQS for contaminated groundwater, and North Carolina Surface Water Standards for contaminated surface water and Federal MCLs and AWQC. There are no North Carolina or Federal ARARs soil or sediment standards; however, EPA Region IV's "Water Quality and Sediment Screening Values" will be used as a TBC ARAR when evaluating ecological impacts in surface waters and sediment.

Table 3-1 compares the maximum concentrations of compounds detected in the groundwater at Site 69 with the NCWQS and the Federal MCLs. As shown on the table, compounds that exceed the established standards include benzene, chloroform, 1,2-dichloroethane, methylene chloride, tetrachloroethene, trans-1,2-dichloroethene, TCE, vinyl chloride, iron, lead, manganese, and zinc. As shown on Table 3-2, maximum detected mercury, zinc, and cyanide concentrations exceed the North Carolina surface water standards, while benzene, chlorobenzene, 1,2-dichloroethene, ethylbenzene, toluene, trans-1,2-dichloroethene, trichloroethene, pentachlorophenol, mercury, zinc, and cyanide exceed AWQC.

3.5.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of activities in wetlands, floodplains, and historical sites. It is not believed that these ARARs would be applicable to remedial activities at the site.

3.5.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration. Action-specific ARARs for Site 69 will not be identified until potential remedial action technologies have been identified.

3.5.5 Potential Remedial Technologies/Alternatives

The purpose of this section is to identify potential remedial technologies for each affected medium in order to identify what data may be necessary to evaluate technologies during the Feasibility Study.

3.5.5.1 Soil

No soil sampling has been conducted at this site. Based on the limited knowledge of what was actually disposed, potential remedial technologies cannot be identified at this time. This is primarily due to the fact that it is not known if wastes have been mixed together during burial. The presence of mixed wastes (e.g., pesticides with volatiles) will have an impact on the selection and combining of technologies to form remedial alternatives. Additionally, the actual dumping/burial areas have not been fully delineated. Therefore, soil samples for subsequent treatability studies or engineering analysis will not be collected as part of this initial RI sampling program.

3.5.5.2 Sediment

Previous studies have identified the presence of low levels of pesticides, inorganics, and pentachlorophenol. Several technologies potentially capable of treating these pesticides and semivolatiles include thermal destruction (incineration), chemical extraction, soil washing, stabilization/fixation, dechlorination (pesticides only) and biodegradation. Technologies for remediation of inorganics include soil washing and stabilization. These technologies have

been preliminarily identified as potentially feasible, based on the limited amount of information available. This listing will be refined as the RI/FS progresses.

Each of the potentially feasible technologies will require specific data in order to evaluate their effectiveness, implementability, and cost.

3.5.5.3 Groundwater

Previous investigations have detected the presence of volatile and inorganic compounds in the shallow aquifer. A number of technologies have been identified as potentially feasible including pumping, containment (via extraction wells), air stripping, carbon adsorption, UV/ozone oxidation, and in-situ chemical treatment.

3.5.5.4 Surface Water

Previous investigations have detected the presence of volatile organics in surface water samples collected from isolated low-lying areas (i.e., small pools or puddles) on site. Potential technologies for remediating these compounds include air stripping, carbon adsorption, UV/ozone, and biodegradation.

3.5.6 Data Limitations

The purpose of this section is to define data limitations with respect to either characterizing the site, assessing health and environmental risks, or evaluating potential feasible technologies. The analytical methods and the level of Quality Assurance/Quality Control used for the analyses of the data provided for review were not included in the background information received for this site, and therefore could not be reported in this Work Plan. Consequently, the data provided is not suitable for use to fully characterize the site or to make an assessment of human health or ecological risks due to the contamination at Site 69. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Section 4 of this RI/FS Work Plan.

3.5.6.1 Wastes and Debris

Information about this site is limited with respect to what has been buried on site. No significant surface wastes, debris, or drums have been noted on site. The locations and

horizontal extent of buried wastes have not been located by any means (e.g., geophysical techniques) except by visually noting depressions, stained soils, and the vegetative growth in certain areas. In general, the type, volume, depth, and location of buried debris have not been characterized.

3.5.6.2 Soil

No soil sampling has been conducted to date. The type of surface and subsurface contamination due to past disposal practices is unknown. Information is not available to assess potential migration to groundwater, impacts to human health, the ecology, or potential off-site migration due to surface runoff.

3.5.6.3 Groundwater

Volatile organic and low levels of inorganic compounds have been detected in groundwater. The wells installed to date are all located outside of the former disposal area. On-site and adjacent off-site groundwater quality is unknown. Groundwater flow directions need to be further evaluated since at least one groundwater divide has been identified by previous investigations. The hydrogeologic characteristics (e.g., transmissivity and permeability) are also unknown. Human health and ecological risks need to be assessed.

3.5.6.4 Sediment

Existing data have identified the presence of pesticides and pentachlorophenol in the sediments of Wallace Creek. Additional analytical data will be needed in order to fully characterize sediment contamination and delineate areas of concern. In addition, human health and ecological risks due to contaminated sediments at Lot 203 need to be assessed.

3.5.6.5 Surface Water

VOCs and metals were detected in on-site surface water at Site 69. The quality of data associated with all previous investigation can not be evaluated. Therefore, all streams should be reassessed.

3.5.6.6 Aquatic Life

Tissues from oysters and mussels in the New River were collected and analyzed during a previous investigation. Two volatile contaminants (acetone and chloromethane) and low levels of inorganics were detected in the samples. No background samples (upgradient) samples were collected for comparison. Because no sediment or surface water samples collected from the New River exhibited contamination, the presence of volatiles and inorganics may not be attributable to the site. Further evaluation of aquatic life in the New River is needed, along with an evaluation of surface water and sediment conditions.

4.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES

The purpose of this section is to define the site-specific RI/FS objectives in order to fulfill the goals of characterizing the problems at each site, assessing potential impacts to the public health and environment, and providing feasible alternatives for consideration in the preparation of the Record of Decision. The site-specific remedial objectives presented in this section have been identified based on the review and evaluation of existing background information, assessment of potential risks to the public health and environment, and the consideration of potential feasible technologies/alternatives.

For each site-specific objective identified, the criteria necessary to meet each objective is identified, along with a general description of the study or investigation required to obtain the information.

4.1 Site 6 - Storage Lot 201

The project objectives, criteria for meeting the objectives, and general investigative methods are presented on Table 4-1 for Site 6 - Storage Lot 201.

4.2 Site 6 - Storage Lot 203 and Wooded Areas of Site 6

The project objectives, criteria for meeting the objectives, and general investigative methods are presented on Table 4-2 for Site 6 - Storage Lot 203, and the wooded areas of Site 6.

4.3 Site 9 - Fire Fighting Training Pit

The project objectives, criteria for meeting the objectives, and general investigative methods are presented on Table 4-3 for Site 9.

4.4 Site 48 - MCAS Mercury Dump

The project objectives, criteria for meeting the objectives, and general investigative methods are presented on Table 4-4 for Site 48.

TABLE 4-1
SITE 6 - STORAGE LOT 201 RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Soil	1a. Assess the extent of soil contamination at former pesticide storage areas.	Characterize pesticide levels in surface and subsurface soils at former storage areas.	Soil Investigation
	1b. Assess the extent of soil contamination at the former PCB storage area.	Characterize PCB levels in surface and subsurface soils at the former storage area.	Soil Investigation
	1c. Assess human health and ecological risks associated with exposure to surface soils.	Characterize contaminant levels in surface and subsurface soils.	Soil Investigation Risk Assessment
	1d. Assess areas of surface soil contamination due to site runoff.	Characterize contaminant levels in surface soils at downslope drainage areas.	Soil Investigation
2. Groundwater	2a. Assess health risks posed by future usage of the shallow groundwater near Lot 201.	Evaluate groundwater quality and compare to ARARs and health-based action levels.	Groundwater Investigation Risk Assessment
	2b. Assess potential impact to groundwater from pesticide-contaminated soil or unknown releases.	Characterize on-site groundwater quality and groundwater quality downgradient from Lot 201.	Groundwater Investigation
	2c. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow aquifer (flow direction, transmissivity, permeability).	Groundwater Investigation (Aquifer Tests) Surface water level measurements in Bear Head Creek

TABLE 4-1 (Continued)
SITE 6 - STORAGE LOT 201 RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
3. Sediment	3a. Assess human health and ecological risks associated with exposure to contaminated sediments.	Characterize the nature and extent of contamination in sediment.	Sediment Investigation in Bear Head Creek Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments.	Evaluate stress to benthic and fish communities.	Aquatic Study in Bear Head Creek
		Identify the presence or absence of contaminants in fish tissue.	Fish Collection and Tissue Analysis Risk Assessment
	3c. Determine the extent of sediment contamination for purposes of identifying areas of remediation.	Identify extent of sediment contamination where contaminant levels exceed risk-based action levels or EPA Region IV TBCs for sediment.	Sediment Investigation (Bear Head Creek) Risk Assessment
4. Surface Water	4a. Assess the presence or absence of surface water contamination in Bear Head Creek.	Determine surface water quality along Bear Head Creek.	Surface Water Investigation
	4b. Assess impacts to Bear Head Creek from groundwater discharge from Site 6, Lot 201 and wooded areas.	Determine surface water quality in Bear Head Creek.	Surface Water Investigation
		Assess groundwater quality from Site 6 or EPA Region IV TBCs for sediment.	Groundwater Investigation

TABLE 4-2
SITE 6 - STORAGE LOT 203 AND WOODED AREAS RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Surface Drums	1a. Determine appropriate treatment/disposal methods of all surface drums.	Identify waste type, contents, and hazardous waste characteristics.	Drum Investigation
	1b. Assess potential impact to soils in drum storage areas.	Characterize surface and subsurface soil contaminant levels in the storage area.	Soil Investigation (Test Pits)
	1c. Assess potential impact to shallow groundwater in drum storage areas.	Characterize on-site shallow groundwater quality.	Groundwater Investigation
2. Buried Waste and/or Drums	2a. Determine and confirm the locations where drums or wastes may be buried.	Identify subsurface anomalies associated with drums or bulk wastes.	Review of Historical Photographs Geophysical Investigation Test Pit Investigation
	2b. Pending the identification of potential buried drums or bulk wastes, determine appropriate treatment/ disposal methods.	Identify waste types, contents, and hazardous waste characteristics.	Drum/Waste Sampling Program
3. Soil	3a. Assess human health and ecological risks associated with exposure to surface soil.	Characterize the nature of soil contamination at Lot 203.	Soil Investigation Risk Assessment
	3b. Assess the potential extent of surface soil contamination due to potential surface runoff.	Determine the presence or absence of soil contamination in downslope or drainage areas.	Soil Investigation Sediment Investigation
	3c. Pending the presence of buried drums/waste, assess the impact to subsurface soil.	Characterize the nature and extent of subsurface contaminant levels at drum/waste disposal areas.	Test Pit Investigation Soil Investigation
	3d. Assess potential impacts to soil from past disposal/ storage activities.	Characterize the nature and extent of soil contamination at Lot 203.	Soil Investigation

TABLE 4-2 (Continued)
SITE 6 - STORAGE LOT 203 AND WOODED AREAS RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
4. Groundwater	4a. Assess human health and ecological risks posed by potential usage or migration of shallow groundwater near Lot 203.	Evaluate on-site and off-site groundwater quality.	Groundwater Investigation Risk Assessment
	4b. Determine the presence or absence of off-site ground-water contamination.	Characterize off-site groundwater quality between Lot 203 and Wallace Creek.	Groundwater Investigation
	4c. Assess on-site groundwater quality at both known and unsuspected disposal areas.	Characterize on-site groundwater quality where disposal practices are known to have occurred.	Geophysical Investigation Groundwater Investigation
	4d. Assess the extent of vertical contaminated groundwater quality in areas where the shallow aquifer has been impacted.	Determine the quality of groundwater in the deeper aquifer.	Groundwater Investigation
5. Sediment	5a. Assess human health and ecological risks posed by sediment contamination in Wallace Creek.	Characterize areas of sediment contamination in Wallace Creek.	Sediment Investigation Risk Assessment
	5b. Assess potential ecological impacts posed by contaminated sediment.	Evaluate stress to benthic and fish communities.	Aquatic Survey (Wallace Creek)
	5c. Identify possible source of semivolatile contamination in Wallace Creek sediments and delineate areas of remediation, if necessary.	Identify extent of sediment contamination in Wallace Creek.	Sediment Investigation (Wallace Creek and the Ravine Area)

TABLE 4-2 (Continued)
SITE 6 - STORAGE LOT 203 AND WOODED AREAS RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
6. Surface Water (Wallace Creek)	6a. Assess human health and ecological risks associated with exposure to surface water.	Evaluate surface water quality throughout Wallace Creek.	Surface Water Investigation Risk Assessment
	6b. Assess ecological impacts from contaminated surface water.	Determine stress to fish or benthic communities.	Aquatic Survey
7. Surface or Subsurface Ordnance Debris	7a. Define areas where ordnance is located and notify DoN for subsequent removal by CLEJ personnel.	Visual inspection by qualified ordnance specialist.	Review of Historical Photographs Site Reconnaissance Geophysical Investigation

TABLE 4-3
SITE 9 - FIRE FIGHTING TRAINING PIT RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Soil	1a. Assess the extent of soil contamination at the training pit and surrounding area.	Characterize contaminant levels in surface and subsurface soils at former storage areas.	Soil Investigation
	1b. Assess human health and ecological risks associated with exposure to surface soils.	Characterize contaminant levels in surface and subsurface soils.	Soil Investigation Risk Assessment
	1c. Assess areas of surface soil contamination due to site runoff.	Characterize contaminant levels in surface soils at downslope drainage areas.	Soil Investigation
2. Groundwater	2a. Assess health risks posed by future usage of the shallow groundwater near Site 6.	Evaluate groundwater quality and compare to ARARs and health-based action levels.	Groundwater Investigation Risk Assessment
	2b. Assess potential impact to groundwater from fuel-contaminated soil.	Characterize on-site groundwater quality and groundwater quality downgradient from Site 6.	Groundwater Investigation
	2c. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow aquifer (flow direction, transmissivity, permeability).	Geophysical Investigation (Aquifer Tests) Surface water level measurements in Bear Head Creek

TABLE 4-3 (Continued)
SITE 9 - FIRE FIGHTING TRAINING PIT RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
3. Sediment	3a. Assess human health and ecological risks associated with exposure to contaminated sediments in Bear Head Creek.	Characterize areas of contaminated sediments and determine levels.	Sediment Investigation in Bear Head Creek Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments.	Evaluate stress to benthic and fish communities.	Aquatic Study in Bear Head Creek
		Identify the presence or absence of contaminants in fish tissue.	Fish Collection and Tissue Analysis Risk Assessment
	3c. Determine the extent of sediment contamination for purposes of identifying areas of remediation.	Identify extent of sediment contamination where pesticide levels exceed health-based action levels.	Sediment Investigation (Bear Head Creek)
4. Surface Water	4a. Assess the presence or absence of surface water contamination in Bear Head Creek.	Determine surface water quality along Bear Head Creek.	Surface Water Investigation
	4b. Assess impacts to Bear Head Creek from groundwater discharge from Site 9.	Determine surface water quality in Bear Head Creek.	Surface Water Investigation
		Assessing groundwater quality from Site 9.	Groundwater Investigation

TABLE 4-4
SITE 48 - MCAS MERCURY DUMP RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Soil	1a. Assess human health and ecological risks associated with exposure to soil.	Characterize areas of surface soil contamination and determine contaminant levels.	Soil Investigation Risk Assessment
	1b. Identify areas impacted by past mercury disposal practices.	Characterize soil anomalies associated with mercury product.	Geophysical Investigation
	1c. Assess potential impacts to groundwater via long-term infiltration (i.e., leaching) or releases.	Characterize subsurface levels of soil contamination.	Soil Investigation
	1d. Identify the presence or absence of contamination at potential disposal areas (wooded areas near photo lab).	Collect soil samples along the tree line that separates the property from the New River.	Soil Investigation
	1e. Determine background inorganic soil quality for comparison purposes.	Collect at least one surface and one subsurface soil sample in an area not known to be impacted by mercury disposal.	Soil Investigation
2. Groundwater	2a. Assess potential impacts to shallow groundwater from past mercury disposal practices.	Install monitoring wells around the site to characterize groundwater quality.	Groundwater Investigation
	2b. Assess health risks posed by potential usage of the shallow groundwater aquifer.	Evaluate groundwater quality in the shallow aquifer.	Groundwater Investigation Risk Assessment
	2c. Determine hydrogeologic characteristics of the shallow groundwater aquifer for fate and transport evaluation and remedial technology evaluation, if required.	Obtain water levels in both groundwater and the New River; determine groundwater flow direction, transmissivity, and permeability.	Groundwater Investigation (Aquifer Tests)

TABLE 4-4 (Continued)
SITE 48 - MCAS MERCURY DUMP RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
3. Sediment	3a. Assess the presence or absence of mercury and other potential contaminants in sediment from surface runoff.	Characterize contaminant levels along the shoreline of the New River and the drainage ditch.	Sediment Investigation
	3b. Assess human health and ecological risks associated with exposure to sediments.	Characterize areas of sediment contamination and determine contaminant levels.	Sediment Investigation Risk Assessment
	3c. Assess ecological impacts posed by sediments.	Evaluate potential stresses to benthic community.	Benthic Study
		Identify the presence or absence of heavy metals and other contaminants in fish tissues.	Fish Sampling/Analysis
	3d. Determine the amount of sediment requiring remediation (disposal and/or treatment).	Collect sediment samples along the shoreline and at various distances offshore for organic and inorganic analysis.	Sediment Investigation
4. Surface Water	4a. Confirm the presence or absence of contamination in the New River.	Collect surface water samples for analysis and compare to AWQC or health-based action levels.	Surface Water Investigation

4.5 Site 69 - Rifle Range Chemical Dump

The project objectives, criteria for meeting the objectives, and general investigative methods are presented on Table 4-5 for Site 69.

TABLE 4-5
SITE 69 - RIFLE RANGE CHEMICAL DUMP RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation
1. Buried Chemical Agents and/or Drums	1a. Determine the locations where drums or chemical agents may be buried.	Identify subsurface anomalies associated with drums or bulk wastes.	Geophysical Investigation Review of Historical Photographs
2. Groundwater	2a. Assess human health risks posed by potential usage of the shallow groundwater aquifer.	Evaluate groundwater quality with respect to ARARs and health-based action levels.	Groundwater Investigation Risk Assessment
	2b. Evaluate the extent of off-site groundwater contamination.	Evaluate groundwater quality downgradient from existing wells that exhibited organic contamination.	Groundwater Investigation
	2c. Determine hydrogeologic characteristics of the shallow groundwater aquifer for fate and transport evaluation and remedial technology evaluation, if required.	Obtain static water levels in both groundwater and nearby streams. Determine groundwater flow directions, transmissivity, and permeability.	Groundwater Investigation (Aquifer Tests)

TABLE 4-5 (Continued)
SITE 69 - RIFLE RANGE CHEMICAL DUMP RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation
3. Sediment	3a. Determine potential impacts to sediments in nearby streams and the New River via off-site migration of surface runoff or groundwater discharge.	Collect samples from nearby streams and the New River for chemical analysis and evaluation.	Sediment Investigation Groundwater Investigation
	3b. Assess human health and ecological risks associated with exposure to sediments (if contaminated).	Characterize the nature and level of contamination in nearby streams.	Sediment Investigation Risk Assessment
	3c. Assess ecological impacts posed by contaminated sediments in New River (and tributaries).	Evaluate stress to benthic or fish communities.	Aquatic Study
		Identify the presence or absence of site-related contaminants in fish tissue.	Aquatic Study
4. Surface Water	4a. Assess human health and ecological risks associated with exposure to surface water.	Characterize the nature and level of contamination in nearby streams and the New River.	Surface Water Investigation Risk Assessment
	4b. Assess impacts to local streams via groundwater discharge.	Determine groundwater flow and correlate with surface water quality.	Groundwater Investigation Surface Water Investigation

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

This section identifies the tasks and field investigations that will be needed to complete RI/FS activities at Sites 6, 9, 48, and 69.

5.1 Task 1 - Project Management

Project Management activities involve such activities as daily technical support and guidance, budget and schedule review and tracking, preparation and review of invoices, manpower resources planning and allocation, and communication with LANTDIV and the Activity.

5.2 Task 2 - Subcontract Procurement

Task 2 involves the procurement of services such as drilling, test pit excavations, ordnance clearance and monitoring, and laboratory analysis. Procurement of these services will be performed in accordance with the Navy CLEAN Contract Procurement Manual. In the event that treatability studies are warranted, procurement of bench-scale or pilot-scale studies will be performed under this task.

5.3 Task 3 - Field Investigations

This section presents an overview of the field investigations to be conducted at Sites 6, 9, 48, and 69. Specific details with respect to the investigative methods are provided in the Field Sampling and Analysis Plan (FSAP). The field investigations described in this section will provide data to meet the overall RI/FS objectives presented in Section 4.0 of this RI/FS Work Plan.

5.3.1 Site 6 - Storage Lots 201 and 203

The following investigations and support activities will be conducted at Site 6:

- Ordnance Survey
- Surveying
- Geophysical Investigations
- Soil Investigations
- Groundwater Investigations

- Surface Water/Sediment Investigations
- Aquatic/Ecological Surveys
- Drum Sampling

5.3.1.1 Ordnance Survey

Baker will subcontract the services of a firm specialized in locating and identifying ordnance, which may be present on the surface and in subsurface soils at Lot 203. The subcontractor will initially perform a site reconnaissance to identify surface ordnance. These areas will be identified to the DoN and DoD for subsequent removal.

During any drilling operations, the subcontractor will assist Baker by monitoring the borehole for buried ordnance at those areas where metallic subsurface anomalies are detected via the geophysical investigation. In the event that either are identified, the field operation will be discontinued and the area identified for subsequent handling by the DoD.

5.3.1.2 Surveying

Sampling grids will be established at Lot 201, Lot 203, and the wooded areas which make up the remaining portions of Site 6. The sampling grids will be used to field locate proposed soil sampling stations. Following the field investigation, all monitoring wells and selected soil and surface water/sediment sampling stations will be surveyed.

Lot 201

As shown on Figure 5-1, sampling grids will be established at the two reported pesticide storage areas and the PCB storage area (Areas A, B, and C on Figure 5-1). Each grid will consist of 25 grid nodes spaced approximately 50 feet from each other. An outer set of sampling points spaced at approximately 100 feet from each other will also be surveyed.

Lot 203

Three sampling grids will be established at Lot 203: one grid will cover the entire site area, including the area outside of the fence along the northern portion of the lot; a second grid will be established in the northeast corner of the lot; and a third grid will be established in the southeast corner of the lot. The grids are depicted on Figure 5-2. Surveying of 100 foot

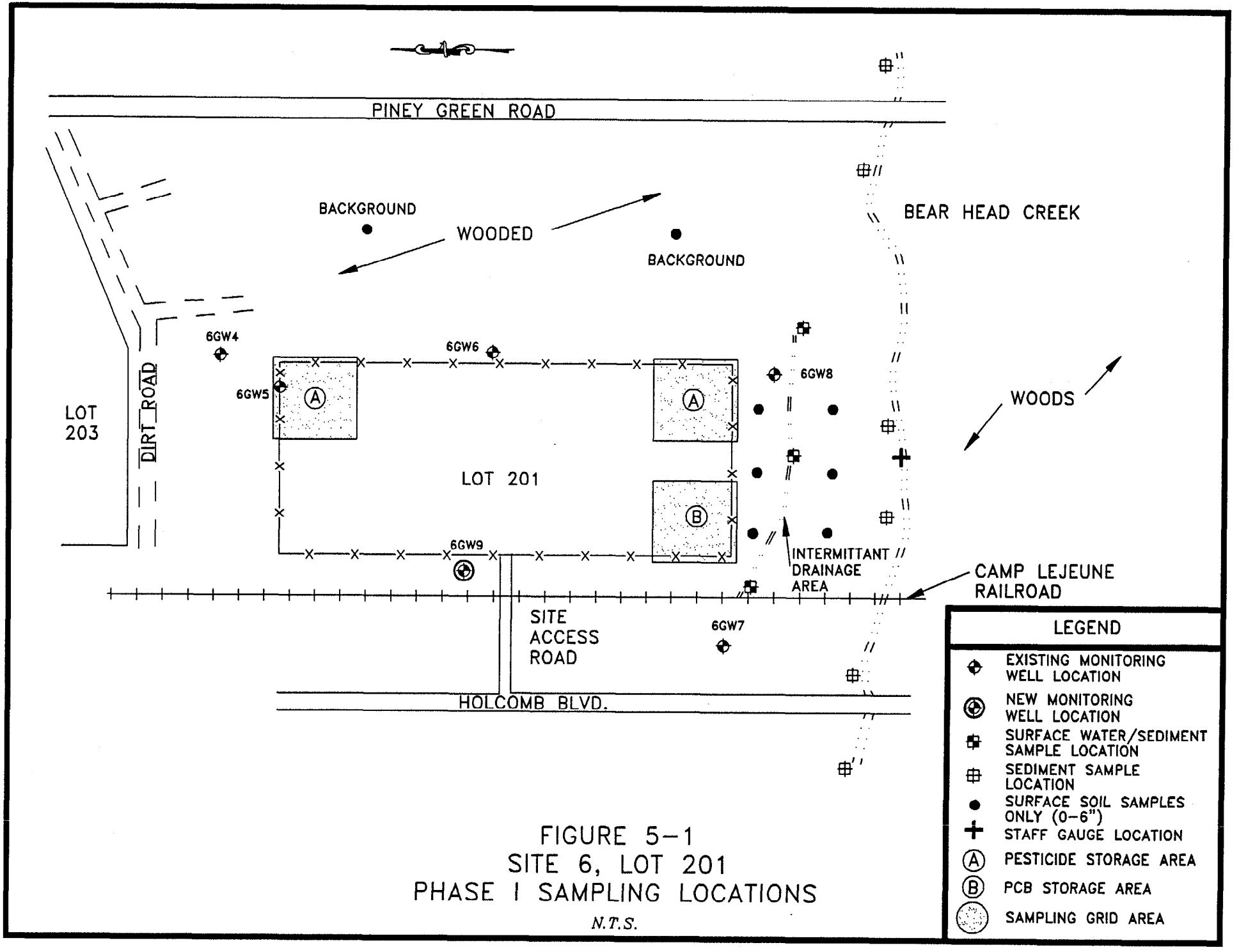


FIGURE 5-1
SITE 6, LOT 201
PHASE I SAMPLING LOCATIONS

N.T.S.

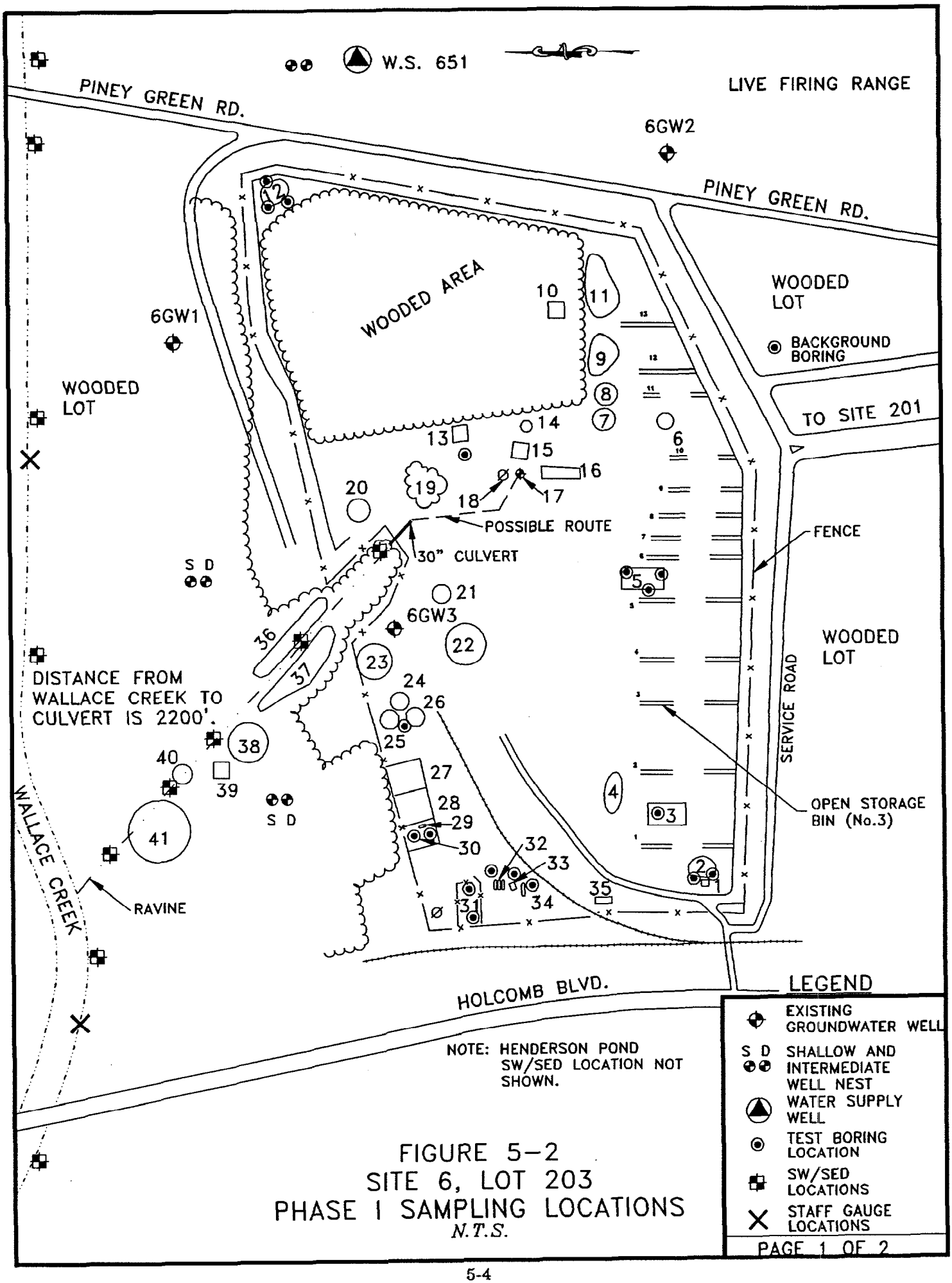


FIGURE 5-2
SITE 6, LOT 203
PHASE I SAMPLING LOCATIONS
N.T.S.

transect lines also will be required for purposes of the geophysical investigation (see Figure 5-2).

As shown on Figure 5-2, a sampling grid will be established at 300 foot spacings throughout Lot 203. This sampling grid will consist of approximately 40 grid nodes. In addition, several sampling stations will be established at less than 300 feet near the southeast corner of the lot as shown on Figure 5-2.

A smaller sampling grid will be established in the northeast and southeast corners of Lot 203 where PCB storage and pesticide disposal activities have been reported. The "PCB" grid will consist of approximately 12 grid points at 100 foot spacings. The "pesticide" grid will consist of approximately 30 grid spacings.

Wooded Areas

A sampling grid will be established in the following wooded portions of the site: between Lot 201 and 203, between Lot 201 and Site 9, and to the east of Lot 201. The grid shall be established at 250 foot spacings throughout these areas as shown on Figure 5-3.

All soil sampling grid points will be identified by the surveyor with wooded stakes and identified with a numbering system by the surveyor. The number of the grid point shall be placed on each wooded stake. The horizontal accuracy shall be within 1 foot and referenced to the North Carolina State Plane Coordinate System. In the event that the proposed station cannot be established due to on-site conditions (e.g., roads, surface obstructions), the grid point will be established and surveyed as close as possible to the proposed location and noted in the surveyor's notes.

Post-Investigation Surveying

All eight existing monitoring wells and those wells established during the investigation at Site 6 will be surveyed. The top of the protective casing, the top of the well casing, and the elevation of the ground surface shall be surveyed. The vertical accuracy shall be 0.01 feet and the horizontal accuracy within 0.1 foot. In addition, test pits or other soil sampling stations (i.e., boreholes) that may be added to the field investigation will be surveyed for horizontal control within 1 foot accuracy at this time. Surface water and sediment sampling locations also will be surveyed to a horizontal accuracy of 1 foot.

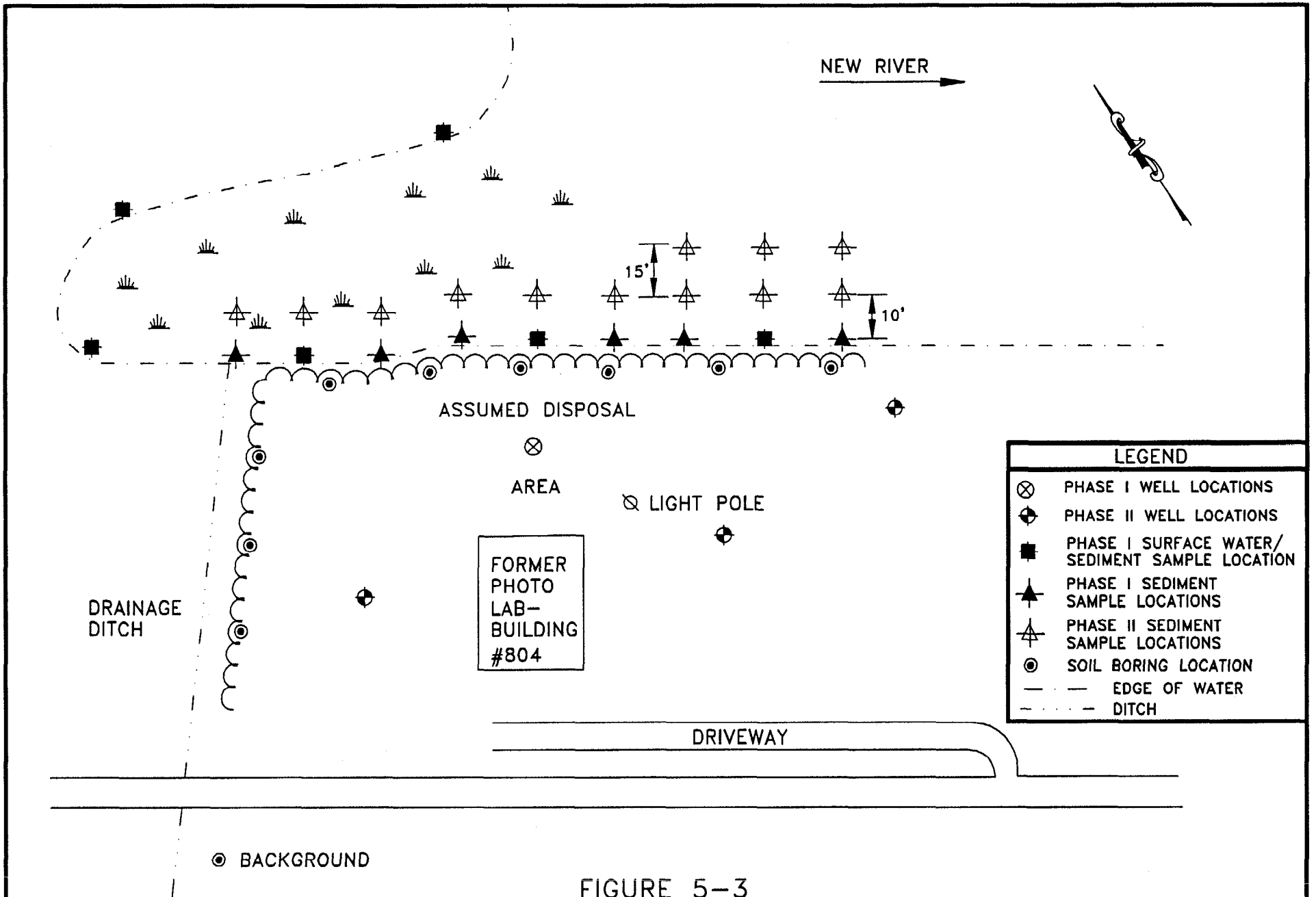


FIGURE 5–3
SITE 48 MCAS MERCURY DUMP
PHASE I AND II SAMPLING LOCATIONS
N.T.S.

5.3.1.3 Geophysical Investigation

A Geophysical Investigation will be conducted at Lot 203 to evaluate whether past disposal practices involved the burial of wastes and/or drums. Electromagnetic terrain profiling (EM) and ground penetrating radar (GPR) techniques will be used to define subsurface soil conditions. The results of the investigations will be used to select test pit and possible additional monitoring well locations.

GPR is an electromagnetic survey technique that produces a graphic cross-sectional view of subsurface stratigraphy and buried "point targets" (i.e., drums, pipelines, tanks, boulders, etc.). Data acquisition is continuous along the lines of coverage; a color monitor provides an immediate view of the data, yielding both horizontal and vertical control of subsurface features.

Physical characteristics, as they pertain to Site 6, which are anticipated to be detected and identified on the radar record include (1) abrupt stratigraphic changes which would define the sidewalls of an excavation; (2) disturbances of any subsurface layering indicative of backfilling; and, (3) highly reflective and attenuated radar signals suggesting the presence of drums or conductive sludge. Typically, reflections occur from buried metallic objects and lithologic changes. Metallic objects, such as utilities, produce a characteristic, high amplitude, parabolic signal on the GPR record. Internal soil structures caused by excavation and subsequent backfilling may also be detected. Excavated areas may appear on the record as "disturbed" areas of high amplitude reflections.

Electromagnetic terrain conductivity (EM) surveying is a geophysical technique used to assess the physical properties of subsurface materials through inductive electrical measurements obtained near ground surface. The conductivity of an earth material is particularly dependent upon water content (porosity and degree of saturation), permeability, salinity or iron content of the water. Conductivity of subsurface pore fluids, clays, clayey tills, water-saturated sediments, and weathered rock (chemically altered to clays) typically exhibit high conductivities; dry sands, gravels, and massive unweathered rock tend to have lower conductivities. Therefore, conductivity contrasts between geologic materials makes EM surveying a valuable technique for: delineation of conductive contaminant plumes, buried wastes, and abandoned trenches/lagoons; identification of weathered and fracture bedrock zones; and lithology mapping including lateral anomalies associated with pockets or lenses of

different materials. EM surveying also is particularly effective for detection of buried metal objects such as pipelines, drums, tanks, and metal debris.

EM data will be acquired by traversing predetermined survey lines spaced 100 feet apart. Geophysical survey lines will be referenced to the surveyed baseline and permanent features (fences, buildings, light stands, etc.) throughout the study areas. Where anomalies are detected, "tighter" traversing will be performed to better delineate the areas of concern.

Data will be recorded digitally and transferred to a portable computer which will be used to generate conductivity contour maps and/or profiles.

The EM and GPR techniques will be conducted throughout the lot, including portions of the woods north of Lot 203. The investigation will collect data over this area by following transects spaced apart at 100 feet. Considering the area of the lot, 100 foot transects should provide a reasonable picture of subsurface conditions at the site. Where anomalies are detected, GPR and EM will be employed along "tighter" traverse lines to better define the areas of concern.

The data and information obtained by these techniques will be used to field locate test pits and on-site monitoring wells.

Following the geophysical investigation, a draft and final report will be prepared that documents the on-site activities, presents and evaluates the data collected, and identifies recommendations for subsequent test pitting and groundwater monitoring activities.

5.3.1.4 Soil Investigation

Soil investigations will be conducted at Lot 201, Lot 203, the Ravine Area within Lot 203, and the wooded areas that make up the remaining portions of Site 6. In addition, soil samples will be collected during the construction of shallow monitoring wells.

Lot 201

There are three areas of concern within Lot 201. As shown on Figure 5-1, Areas "A" and "B" are reportedly pesticide storage areas. Area "C" is reportedly a PCB storage area. Sampling grids consisting of 25 sampling stations at 50 foot spacings (an inner grid) will be established

at each area as described above in Section 5.3.1.2. In addition, an outer (confirmatory) grid consisting of 12 sampling stations at 100 foot spacings will be surveyed.

Test borings will be augered and soil samples collected via ASTM Method D1586-84 at each sample station. This will comprise a total of 37 boreholes at each area of concern. Samples will be collected from the ground surface (top six inches) and at 5-foot intervals to the top of the water table, which is estimated to be approximately five to ten feet below ground surface across the site. Therefore, it is possible that as many as three samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis.

Soil samples collected from Areas A and B (pesticide storage areas) within the inner grid (i.e., 50-foot spacings) will be analyzed for Target Compound List (TCL) pesticides via Contract Laboratory Program (CLP) protocols (Level IV data quality). Samples collected from the inner grid will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround). Soil samples collected from the outer grid (i.e., 100 foot spacings) will be analyzed within 14 days by the laboratory. The outer grid will serve to determine whether further soil sampling is required to delineate the extent of surface or subsurface soil contamination.

Soil samples collected from Area C (PCB storage area) within the inner grid (i.e., 50-foot spacings) will be analyzed for Target Compound List (TCL) polychlorinated biphenyls (PCBs) via Contract Laboratory Program (CLP) protocols (Level IV data quality). Samples collected from the inner grid will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround). Soil samples collected from the outer grid (i.e., 100 foot spacings) will be analyzed within 14 days by the laboratory. The outer grid will serve to determine whether further soil sampling is required to delineate the extent of surface or subsurface soil contamination.

A selected number of surface and subsurface soil samples (see Figure 5-1) from the outer grid and the inner grid within each area of concern will be analyzed for full TCL organics and Target Analyte List (TAL) inorganics via CLP protocol (Level IV data quality). These samples will serve to assess human health and environmental risks and will provide data to fully characterize surface and subsurface soils in these areas.

The center borehole from each inner grid will serve to evaluate engineering parameters. All soil samples from this boring will be analyzed for grain size, moisture density, total TCLP,

organic chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, and reactivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction and solidification/fixation, or off-site treatment and disposal options.

Table 5-1 summarizes the soil sampling program at Lot 201.

Lot 203 - Grid Sampling

As shown on Figure 5-2, a PCB storage area and a pesticide disposal area have been reported in the northeast and southeast corner of this lot, respectively. As discussed previously in Section 5.3.1.2, sampling grids will be established at both of these areas. In addition, a sampling grid will be established over the entire lot. The grid established at the reported PCB storage area will consist of 12 sampling stations. The pesticide disposal area grid will consist of 30 sampling stations. The grid over the entire lot will comprise approximately 40 sampling stations.

Boreholes will be augered at each grid point and soil samples will be obtained via ASTM Method D1586-84. Soil samples will be collected from the ground surface (top six inches) to the top of the water table. Based on the reported depth of the water table (7 to 22 feet bgs), as many as five subsurface soil samples could be collected from each borehole. It is anticipated that the average location will yield up to three samples, including the surface sample.

Soil samples collected from the PCB storage area will be analyzed for TCL PCBs (Level IV data quality). Soil samples collected from the pesticide disposal area will be analyzed for full TCL pesticides via CLP methods (Level IV data quality).

Soil samples collected from the grid over the entire lot will be analyzed for full TCL organics and TAL inorganics using CLP protocols (Level IV data quality). These samples will be analyzed within 14 days. Areas where elevated levels of contaminants are detected will be further investigated. These areas will be determined during the field investigation by EPA Region IV and LANTDIV.

In the event that an area within Lot 203 exhibits significant contamination, it may be necessary to conduct additional soil investigations. If required, 50-foot grid spacings will be established between the original grid spacings at each area of concern. Soil borings will be augered and samples will be collected at 5-foot intervals to the top of the water table. The

TABLE 5-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 6, Lot 201	Soil - Area A	20 borings/40 to 60 samples[2]	TCL Pesticides	IV	CLP	Routine[3]
		5 borings/10 to 15 samples[2]	TCL Organics, TAL Inorganics	IV	CLP	14 days
		12 borings/24 to 36 samples[2]	TCL Pesticides	IV	CLP	14 days
		1 boring/2 to 3 samples[2]	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 350.2	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine
Site 6, Lot 201	Soil - Area B	20 borings/40 to 60 samples[2]	TCL Pesticides	IV	CLP	Routine[3]
		5 borings/10 to 15 samples[2]	TCL Organics, TAL Inorganics	IV	CLP	14 days
		12 borings/24 to 36 samples[2]	TCL Pesticides	IV	CLP	14 days
		1 boring/2 to 3 samples[2]	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 350.2	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine

TABLE 5-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 6, Lot 201	Soil - Area C	20 borings/40 to 60 samples[2]	TCL PCBs	IV	CLP	Routine[3]
		5 borings/10 to 15 samples[2]	TCL Organics, TAL Inorganics	IV	CLP	14 days
		12 borings/24 to 36 samples[2]	TCL PCBs	IV	CLP	14 days
		1 boring/2 to 3 samples[2]	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 350.2	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine
Site 6, Lot 203	Soil - PCB Storage Area	8 borings/16 to 24 samples[2]	TCL PCBs	IV	CLP	Routine[3]
		4 borings/8 to 12 samples[2]	TCL PCBs	IV	CLP	14 days
	Soil - Pesticide Disposal Area	24 borings/48 to 72 samples[2]	TCL Pesticides	IV	CLP	Routine[3]
		6 borings/12 to 18 samples[2]	TCL Pesticides	IV	CLP	14 days
	Soil - Entire lot including wooded areas to the north	44 borings/88 to 132 samples[2]	TCL Organics, TAL Inorganics	IV	CLP	14 days

TABLE 5-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 6, Lot 203 (continued)	Soil - Areas of concern identified by the above investigation	5 borings per area of concern/10 to 20 samples	TCL Organics, TAL Inorganics	IV	CLP	Routine
		1 boring per area of concern/2 to 3 samples[2]	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 350.2	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine
	Soil - Test Pits	6 per test pit (estimated)	TCL Organics TAL Inorganics	IV	CLP	Routine
	Waste - Test Pit	1 per test pit (if drums or wastes are encountered)	Total TCLP	III	40 CFR 261	Routine
			RCRA Hazardous Waste	IV	40 CFR 261	Routine
	Soil - Ravine	12 locations; 2 samples per location	TCL Organics TAL Inorganics	IV	CLP	Routine
	Wooded areas between Lot 201 and 203 and between Lot 201 and Site 9	43 borings/86 to 172 samples (estimated)[4]	TCL Organics TAL Inorganics	IV	CLP	14 days
		1 boring per area of concern/ 2 to 4 samples (estimated)	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 350.2	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine

TABLE 5-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 6	Soil - Monitoring Well Boreholes	22 borings/44 samples	TCL Organics TAL Inorganics	IV	CLP	Routine
	Groundwater	37 per round (8 existing, 24 new shallow, and 5 new deep wells)	TCL Organics TAL Inorganics	IV	CLP[6]	Routine
		5 within Lot 203 based on geophysical investigation) (this number is estimated)	TCL Organics TAL Inorganics	IV	CLP[6]	Routine
		6 (one round only)	BOD COD TSS TDS TVS	III	SM 5210 EPA 410.1 EPA 160.2 EPA 160.1 EPA 160.4	Routine Routine Routine Routine Routine
	Surface Water - Bear Head Creek	7 stations/14 samples (one from each bank)	TCL Organics, TAL Inorganics	IV	CLP	Routine
	Surface Water - Wallace Creek	11	TCL Organics, TAL Inorganics	IV	CLP	Routine
	Surface Water - Ravine	8	TCL Organics, TAL Inorganics	IV	CLP	Routine
	Sediment - Bear Head Creek	7 stations; 2 surface and 2 subsurface per station; 28 total samples	TCL Organics TAL Inorganics	IV	CLP	Routine
			TOC	III	EPA 415.1	Routine
	Sediment - Wallace Creek	11 stations; 2 surface and 2 subsurface samples per station; 44 total samples	TCL Organics TAL Inorganics	IV	CLP	Routine
			TOC	III	EPA 415.1	Routine
	Sediment - Ravine Area	8 stations; 2 samples per station; 16 total samples	TCL Organics TAL Inorganics	IV	CLP	Routine
			TOC	III	EPA 415.1	Routine

TABLE 5-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 6 (continued)	Aquatic (fish) - Bear Head Creek	3 stations; 3 samples per station; 9 total samples	TCL Organics TAL Inorganics	III	SAS[5]	Routine
	Aquatic (fish) - Wallace Creek	4 stations; 3 samples per station; 12 total samples	TCL Organics TAL Inorganics	III	SAS[5]	Routine
	Surface Drums	12 drums	Total TCLP Corrosivity Ignitability Reactivity	III III III III	40 CFR 261 40 CFR 261 40 CFR 261 40 CFR 261	Routine Routine Routine Routine
Site 9	Soil - Fire Training Pit and Oil Water Separator Area	23 borings/46 to 69 samples	TPH	III	EPA 418.1	7 days
		7 borings/14 to 21 soil samples	TCL Organics TAL Inorganics	IV	CLP	Routine
		1 boring/2 to 3 samples[2]	Grain Size Moisture Density Total TCLP Chlorine, Residual Total Fluoride Nitrogen (organic) Alkalinity (total) Corrosivity Ignitability Reactivity TOC	III III III III III III III III III III III	ASTM D422 ASTM D698 40 CFR 261 EPA 330.5 SM 4500-F EPA 350.2 SM 2320-B 40 CFR 261 40 CFR 261 40 CFR 261 EPA 415.1	Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine

TABLE 5-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 9 (continued)	Soil - Storage Tank Area	7 borings/14 to 21 samples	TPH	III	EPA 418.1	7 days
		3 borings/6 to 9 soil samples	TCL Organics TAL Inorganics	IV	CLP	Routine
		1 boring/2 to 3 samples[2]	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 350.2	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine
	Soil - Monitoring Well Boreholes	5 borings/10 samples	TCL Organics TAL Inorganics	IV	CLP	Routine
	Groundwater	9 samples per round (3 existing and 6 new wells)	TCL Organics TAL Inorganics	IV	CLP[6]	Routine
Site 48	Soil - Edge of property	7 borings/14 samples	TAL Inorganics	IV	CLP	Routine
		2 borings/4 samples	TCL Organics TAL Inorganics	IV	CLP	14 days
	Soil - Monitoring Well Boreholes	2 borings/6 to 8 samples	TCL Organics TAL Inorganics	IV	CLP	Routine
		3 borings/9 to 12 samples	TAL Inorganics	IV	CLP	Routine

TABLE 5-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 48 (continued)	Soil - Locations to be determined based on geophysical investigation	5 borings per area of concern/ 10 samples	TCL Organics[7] TAL Inorganics	IV	CLP	Routine
		1 boring per area of concern/ 2 samples	Grain Size Moisture Density Total TCLP Chlorine, Residual Total Fluoride Nitrogen (organic) Alkalinity (total) Corrosivity Ignitability Reactivity TOC	III III III III III III III III III III III	ASTM D422 ASTM D698 40 CFR 261 EPA 330.5 SM 4500-F EPA 350.2 SM 2320-B 40 CFR 261 40 CFR 261 40 CFR 261 EPA 415.1	Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine
	Groundwater	3 samples per round	TAL Inorganics	IV	CLP[6]	Routine
		2 samples per round	TCL Organics TAL Inorganics	IV	CLP	19 days
		1 sample per round	BOD COD TSS TDS TVS	III III III III III	SM 5210 EPA 410.1 EPA 160.2 EPA 160.1 EPA 160.4	Routine Routine Routine Routine Routine
	Surface water - Intermittent stream	3 samples	TCL Organics[9] TAL Inorganics	IV	CLP[6]	Routine
	Surface water - New River	5 samples	TCL Organics[10] TAL Inorganics	IV	CLP[6]	Routine
	Surface water - Marsh Area	2 samples	TCL Organics[9] TAL Inorganics	IV	CLP[6]	Routine
	Sediment - Intermittent Stream	3 stations/6 samples	TCL Organics[9] TAL Inorganics	IV	CLP[6]	Routine
			TOC	III	EPA 415.1	Routine

TABLE 5-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 48 (continued)	Sediment - New River	5 stations/10 samples	TCL Organics[10] TAL Inorganics	IV	CLP[6]	Routine
			TOC	III	EPA 415.1	Routine
		7 stations/14 samples	TAL Inorganics	IV	CLP	Routine
	Sediment - Marsh Area	2 stations/4 samples	TCL Organics[9] TAL Inorganics	IV	CLP[6]	Routine
			TOC	III	EPA 415.1	Routine
	Aquatic (fish) - New River and Marsh	5 stations/15 samples	TCL Organics[11] TAL Inorganics	III	SAS[5]	Routine
	Aquatic (shellfish) - New River and March	5 stations/15 samples	TCL Organics[11] TAL Inorganics	III	SAS[5]	Routine
Site 69	Soil - Hydropunching	16 borings/32 samples	TCL Organics TAL Inorganics	IV	CLP	Routine
			CSM	III	SAS[8]	Routine
	Groundwater - Hydropunching	16 samples	TCL Volatiles	III	EPA 601/602	24 hours
	Groundwater - Monitoring Wells	12 samples per round	TCL Organics TAL Inorganics	IV	CLP	Routine
			CSM	III	SAS[8]	Routine
	Sediment - Unnamed Tributary to New River	3 stations/6 samples	TCL Organics TAL Inorganics	IV	CLP	14 day
			TOC	III	EPA 415.1	Routine
	Sediment - Everett Creek	3 stations/6 samples	TCL Organics TAL Inorganics	IV	CLP	14 day
			TOC	III	EPA 415.1	Routine

TABLE 5-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 69 (continued)	Sediment - New River	3 stations/6 samples	TCL Organics TAL Inorganics	IV	CLP	14 day
			TOC	III	EPA 415.1	Routine
	Surface water - Unnamed Tributary to New River	3 samples	TCL Organics TAL Inorganics	IV	CLP	14 day
	Surface water - Everett Creek	3 samples	TCL Organics TAL Inorganics	IV	CLP	14 day
	Surface water - New River	3 samples	TCL Organics TAL Inorganics	IV	CLP	14 day
	New River-Fish[12]	3 stations/9 samples total	TCL Organics[13] TAL Inorganics[13]	III	SAS[5]	Routine
	New River - Shellfish[12]	3 stations/9 samples total	TCL Organics[13] TAL Inorganics[13]	III	SAS[5]	Routine
	Everett Creek - Fish[12]	3 stations/9 samples total	TCL Organics[13] TAL Inorganics[13]	III	SAS[5]	Routine
	Everett Creek - Shellfish[12]	1 station/3 samples	TCL Organics[13] TAL Inorganics[13]	III	SAS[5]	Routine
	Unnamed Tributary to the New River - Fish[12]	3 stations/9 samples	TCL Organics[13] TAL Inorganics[13]	III	SAS[5]	Routine

BOD - Biological oxygen demand
COD - Chemical oxygen demand
TSS - Total suspended solids
TDS - Total dissolved solids
TVS - Total volatile solids
TOC - Total organic carbon
TPH - Total petroleum hydrocarbons
SAS - Special analytical services
CSM - Chemical surety compounds (see Tables 5-3 and 5-4)

(1) Baseline no. of samples do not include field QA/QC samples.
(2) Assumes 2 to 3 samples per borehole.
(3) Routine analytical turnaround is between 28 to 40 days following receipt of sample.
(4) Assumes 2 to 4 samples per borehole.
(5) Standard operating procedures for the conduct of marine environmental sampling and analysis (OSWER, 1991).
(6) Volatiles will be analyzed by EPA Method 601/602. Second column confirmation required.
(7) Center borehole only with 14 day turnaround.
(8) Modified 8270 (see QAPP).
(9) Optional based on presence of organics in onsite soil or groundwater.
(10) Three of the five stations will undergo organic analysis.
(11) Approximately 10 percent of samples. However, if organics are detected in onsite soil or groundwater samples, all fish/shellfish samples will be analyzed for TCL organics in addition to TAL inorganics.
(12) To be conducted pending presence of site-related contaminants in surface water or sediment samples.
(13) Actual analysis will be dependent on those site-related constituents detected in surface water or sediment samples. In any event, at least 10 percent of the fish and shellfish samples will be analyzed for full TCL organics and TAL inorganics.

samples will be analyzed for contaminant groups of concern (e.g., volatiles, semivolatiles, PCBs, pesticides, or inorganics), that are detected and determined to be significant during the initial sampling. In addition, soil samples collected from one test boring in each area of concern will be analyzed for grain size, moisture density, total TCLP, organic chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, and reactivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction, biological treatment, and solidification/fixation, or off-site treatment and disposal.

The grid sampling program at Lot 203 is summarized on Table 5-1.

Lot 203 - Test Pits

Test pits will be excavated at those areas of concern identified by the Geophysical Investigations. The test pits shall be excavated to the water table. The areal extent of excavation shall be determined in the field based on the areal extent of the area of concern detected by the Geophysical Investigation. The excavation shall extend from center to center and from end to end of the area of concern unless it is exceptionally large (e.g., over 30 feet in either direction).

Soil samples will be collected from the test pits at five foot intervals, beginning at the ground surface. All samples will be collected from the bucket of the backhoe. All soil samples will be analyzed for full TCL organics and TAL inorganics via CLP Methods.

In the event that wastes or drums are encountered, samples of the waste or drum contents (unless the drums are intact) shall be obtained. The samples shall only be obtained from the bucket of the backhoe. These soil samples shall be analyzed for full TCLP organics and inorganics and RCRA Hazardous Waste Characteristics.

Table 5-1 outlines the soil sampling program during test pitting at Lot 203.

Lot 203 - Ravine Area

Soil samples will be collected from the banks of the ravine at the approximate locations shown on Figure 5-2. The sampling plan for the ravine is to investigate soil conditions from the top of

the ravine to the area near Wallace Creek. The sampling stations shall be approximately 200 feet apart on both sides of the ravine.

Due to the steepness of the ravine, the soil samples shall be collected by a backhoe. A surface and subsurface sample shall be obtained. The depth of the subsurface sample will be dependent on access restrictions and the reach of the backhoe bucket. If possible, a sample collected from a depth of at least five feet will be attempted. All soil samples from the ravine will be analyzed for full TCL organics and TAL inorganics via CLP protocols (Level IV data quality).

The soil sampling plan for the Ravine Area is summarized on Table 5-1.

Wooded Area Within Site 6

A soil sampling grid will be established throughout Site 6 in the wooded areas to characterize soil conditions where random dumping and disposal activities may have occurred. As described previously in Section 5.3.1.2, sampling points will be established throughout the wooded areas at 250 foot spacings. Test borings will be augered at each grid point and soil samples will be collected in accordance with ASTM Method D1586-84. Soil samples will be collected from the ground surface (top six inches) and at five foot intervals to the top of the water table, which is expected to fluctuate between 1 foot and 20 feet throughout the wooded areas. The sampling locations are depicted on Figure 5-3.

All soil samples will be analyzed for TCL organics and TAL inorganics using CLP Methods (Level IV data quality). All samples will be analyzed within 14 days following receipt of the sample by the laboratory.

In the event that an area exhibits significant contamination (to be determined by EPA Region IV and LANTDIV), it may be necessary to conduct additional soil investigations to further characterize the extent of contamination. If required, 50-foot grid spacings will be established between the original grid spacings at each area of concern. Soil borings will be augered and samples will be collected at 5-foot intervals to the top of the water table. The samples will be analyzed for contaminant groups of concern (e.g., volatiles, semivolatiles, PCBs, pesticides, or inorganics), that are detected and determined to be significant during the initial sampling. In addition, soil samples collected from one test boring in each area of concern will be analyzed for grain size, moisture density, total TCLP, organic chlorine, total fluoride, organic nitrogen,

alkalinity, reactivity, corrosivity, and ignitability. These parameters will help in evaluating potential applicable technologies such as thermal destruction, biological treatment, and solidification/fixation, or off-site treatment and disposal.

The grid sampling program at this area is summarized on Table 5-1.

Soil Sampling During Well Construction

A minimum of 23 shallow monitoring wells will be constructed at Site 6. Soil samples shall be collected at just above and just below the water table during the drilling of monitoring well boreholes to correlate groundwater results with subsurface soil conditions. Samples collected below the water table (saturated soil conditions) will provide analytical data to evaluate migration potentials in the risk assessment. All soil samples will be analyzed for full TCL organics and TAL inorganics via CLP Methods (Level IV data quality).

Background Soil Samples

Soil samples collected from monitoring well boreholes 6GW29, 6GW30, 6GW23, and 6GW24 (see Figure 5-4) will represent background soil conditions. No known waste disposal activities are believed to have occurred in the area just north of Wallace Creek or to the east of Piney Green Road.

5.3.1.5 Groundwater Investigation

Groundwater Investigations will be conducted at Site 6 to assess groundwater quality at Lot 201, Lot 203, and the wooded portions of the site. The groundwater investigations will consist of the construction of monitoring wells throughout Site 6, the collection of two rounds of groundwater samples and water level measurements, and aquifer testing.

Monitoring Well Construction

Eight shallow monitoring wells were previously installed at Site 6 (wells 6GW1 through 6GW8) as shown on Figure 5-4 to monitor groundwater quality. Because the site boundary has been expanded, and because there are areas that need further evaluation throughout the site, at least 23 shallow and 5 deep monitoring wells will be installed here during this RI. The

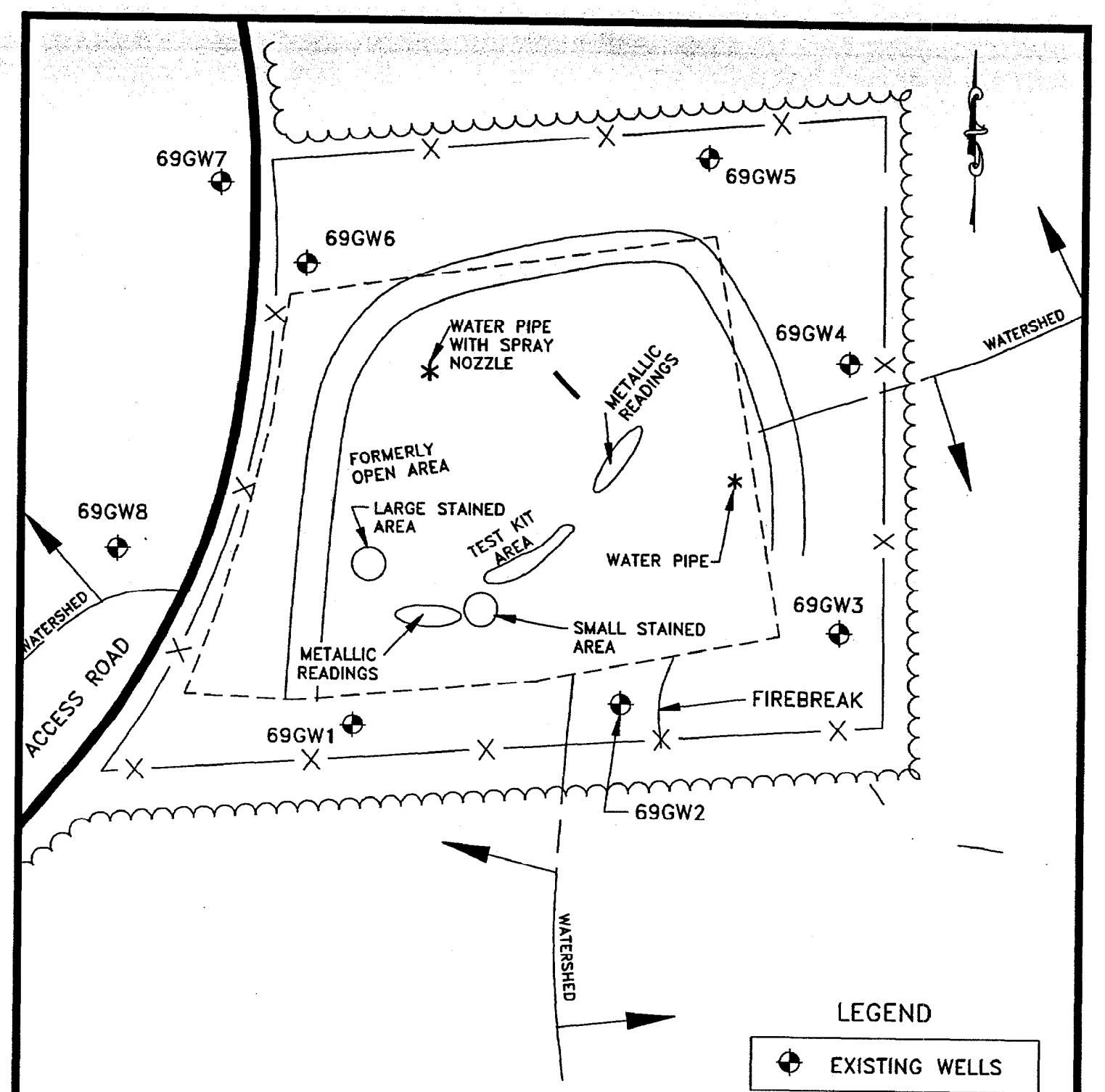


FIGURE 5-4
SITE 69
PHASE I MONITORING WELL
SAMPLING LOCATIONS
N.T.S.

proposed well locations are shown on Figure 5-4. Table 5-2 provides the rationale and purpose for each proposed well location.

All shallow wells will be constructed of 4-inch PVC casing to a depth of at least 15 feet below the top of the water table. Four-inch wells are proposed since they can easily be converted into extraction wells if required. Additionally, pumping tests can be conducted more effectively in four inch wells. Well screens will be a standard 10 foot length. This well depth and screen length will allow for seasonal fluctuations in the water table and will represent the surficial aquifer at the site. Detailed well construction procedures are provided in the Field Sampling and Analysis Plan (FSAP).

Additional groundwater monitoring wells will be installed in areas of concern that are identified during the geophysical investigation. It is estimated that up to five additional wells may be installed in these areas (Table 5-1).

Five deep monitoring wells are proposed. These wells also will be constructed of 4-inch PVC casing and screen. These wells will be constructed to a depth below the confining or semi-confining silt or clayey layer in order to monitor the deeper Castle Hayne aquifer. These wells could extend as deep as 150 feet. Well construction details are provided in the FSAP.

Groundwater Sampling and Analysis

Two rounds of groundwater samples will be collected from each well. The first round will be collected during this field investigation, which is anticipated to occur in the Summer of 1992. The second round of groundwater samples will be collected in November or December 1992. The early summer season is considered a dryer season than the winter season in this area.

All groundwater samples will be analyzed for full TCL organics and TAL inorganics. TCL volatiles will be analyzed via Method 601/602. All other organic and inorganic analyses will be analyzed via CLP protocols. Inorganic samples will be analyzed for both total and dissolved constituents. Only total (unfiltered) inorganic analyses will be used in the risk assessment.

Two wells from Lot 201 (wells 6GW12 and 6GW22), Lot 203 (wells 6GW1 and 6GW1D), and the wooded areas of Site 6 (wells 6GW10 and 6GW19) will also be sampled for analysis of engineering parameters to evaluate process options for treatment of the groundwater. These

TABLE 5-2

MONITORING WELL SUMMARY AND RATIONALE
SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Site No.	Well Designation	General Location	Purpose
6	6GW1*, 6GW6, 6GW27, ad 6GW28	North of Lot 203	Monitor shallow groundwater quality downgradient from Lot 203.
	6GW1D, 6GW27D, and 6GW28D	North of Lot 203	Monitor deep groundwater quality downgradient from Lot 203.
	6GW3* and 6GW27	North of Lot 203 near the Ravine Area	Monitor shallow groundwater quality on both sides of the Ravine Area.
	6GW30	North of Wallace Creek	Monitor groundwater quality across Wallace Creek to assess other potential contaminant plumes from other unknown sources or to assess the extent of horizontal migration from Lot 203.
	6GW2* and 6GW29	East of Lot 203	Monitor upgradient groundwater quality in the surficial aquifer.
	6GW2D	East of Lot 203	Monitor upgradient groundwater quality in the deep aquifer.
	6GW4*, 6GW20, 6GW21, 6GW25, and 6GW19	South of Lot 203 and North of Lot 201 in a wooded portion of Site 6	Monitor groundwater quality in this portion of site where random disposal of wastes may have occurred. These wells also will assess upgradient conditions with respect to Lot 201.
	6GW5* and 6GW22	Area A, Lot 201	Monitor upgradient and downgradient groundwater quality in the surficial aquifer.
	6GW14-6GW19 and 6GW6*	East of Lot 201 in a wooded portion of Site 6	Monitor groundwater quality in the surficial aquifer upgradient of Lot 201 and monitor groundwater quality in this portion of the site where random dumping has occurred.
	6GW8*, 6GW7*, 6GW12, and 6GW13	Downgradient from Area B and Area C, Lot 201	Monitor shallow groundwater quality downgradient of the former pesticide and PCB storage areas.
	6GW7D	Downgradient of Lot 201 and Area C	Monitor deep groundwater quality downgradient of Lot 201.
	6GW9, 6GW10, and 6GW11	South of Bear Head Creek	Monitor shallow groundwater quality in this wooded portion of Site 6 where random disposal has occurred. These wells will also serve to assess groundwater quality downgradient from Site 9.

TABLE 5-2 (Continued)

MONITORING WELL SUMMARY AND RATIONALE
SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

Site No.	Well Designation	General Location	Purpose
9	9GW1*, 9GW6, 9GW7, ad 9GW8	Near the fire training pit and oil water separator	Monitor on-site groundwater quality in the surficial/aquifer where ongoing fire training exercises occur.
	9GW2*, 9GW3*, and 9GW7	North of the training area	Monitor downgradient groundwater quality in the surficial aquifer.
	9GW7D	North of the training area	Monitor downgradient groundwater quality in the deep aquifer.
	9GW4	Southeast of Site 9	Monitor upgradient groundwater quality.
48	48GW1 and 48GW2	Southwest and west of Site 48	Monitor off-site groundwater quality.
	48GW3 and 48GW4	Within the reported disposal area	Monitor on-site groundwater quality.
	48GW5	Southwest of the reported disposal area	Monitor downgradient groundwater quality in the surficial aquifer.
69	69GW1*, 69GW2*, and 69GW3*	South of the former disposal area	Monitor shallow groundwater quality near the surface.
	69GW4*	East of the former disposal area	Monitor shallow groundwater quality near the surface.
	69GW5* and 69GW6*	North of the former disposal area	Monitor shallow groundwater quality near the surface.
	69GW7* and 69GW8*	West of the former disposal area	Monitor shallow groundwater quality near the surface.
	69GW9	North of the site (to be located in the field)	Monitor off-site shallow groundwater quality.
	69GW10	East of the site (to be located in the field)	Monitor off-site shallow groundwater quality.
	69GW11	West of the site (to be located in the field	Monitor off-site shallow groundwater quality.
	69GW12	South of the site (to be located in the field)	Monitor off-site shallow groundwater quality.

analytical parameters will include: biological oxygen demand, chemical oxygen demand, total suspended solids (TSS), total dissolved solids (TDS), and total volatile solids (TVS).

Sampling procedures are outlined in the FSAP.

Water Level Measurements

Static water level measurements will be collected from each well during both sampling rounds. Water level measurements shall be collected within a four hour period, if possible. In addition, groundwater levels in at least one shallow and deep well will be recorded continuously with automated data loggers for a 24-hour period to determine tidal influences. Water level measurement techniques are described in the FSAP. Groundwater level data will be used to evaluate groundwater flow direction and aquifer conditions.

Aquifer Testing

Aquifer tests will be conducted to determine shallow and deep aquifer characteristics such as groundwater flow velocity, hydraulic conductivity, and transmissivity. It is anticipated that aquifer tests will be conducted at Lot 201 and Lot 203. The tests will involve groundwater pumping from monitoring wells with a submersible pump and recording changes in water levels in nearby wells or wells monitoring deeper flow systems.

The design of the site-specific aquifer tests will depend on the preliminary results of the RI. The spatial distribution of the monitoring wells installed during the RI and groundwater analytical data will influence the design of the pumping tests. The selection of pumping durations, location of observation wells (additional observation wells will be necessary), and treatment/disposal options for the extracted groundwater will be determined as field data are evaluated.

A scope of work and schedule for conducting aquifer tests at Site 6 will be prepared when more information is available with respect to present-day site conditions. It is anticipated that the aquifer tests would include the following:

- Selection of pumping and observation wells at each lot or area of concern within Site 6.
- Step drawdown tests on the pumping well to determine the appropriate pumping rate.

- Recording of water levels in the pumping and observation wells with a pressure transducer (some water levels in other wells may be recorded manually).

- Short or long-term pumping tests (actual duration would be dependent on stabilization of groundwater conditions).

- Evaluation of data collected to determine aquifer characteristics.

5.3.1.6 Surface Water and Sediment Investigation

Surface Water and Sediment Investigations will be conducted on Bear Head Creek and Wallace Creek to assess impacts to these streams and the environment. This section outlines the sampling and analytical requirements. Specific sampling procedures can be found in the FSAP.

Bear Head Creek

As shown in Figure 5-5, seven surface water and sediment sampling stations have been identified to characterize upgradient site conditions, potential impacts from both Site 6 and Site 9 (located south of Bear Head Creek), and downgradient conditions. One surface water sample will be collected from each bank of the creek per sampling station (i.e., 14 surface water samples). A surface (top six inches) and a subsurface (6 to 12 inches bgs) sediment sample will be collected from each bank of the creek at each station (i.e., 28 sediment samples). Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, then pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample. In addition, downstream sample stations will be sampled first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device. The FSAP discusses both surface water and sediment sampling activities.

Wallace Creek

As shown in Figure 5-5, eleven surface water and sediment sampling stations will be established in Wallace Creek to assess potential impacts from Site 6, Lot 203 and the wooded

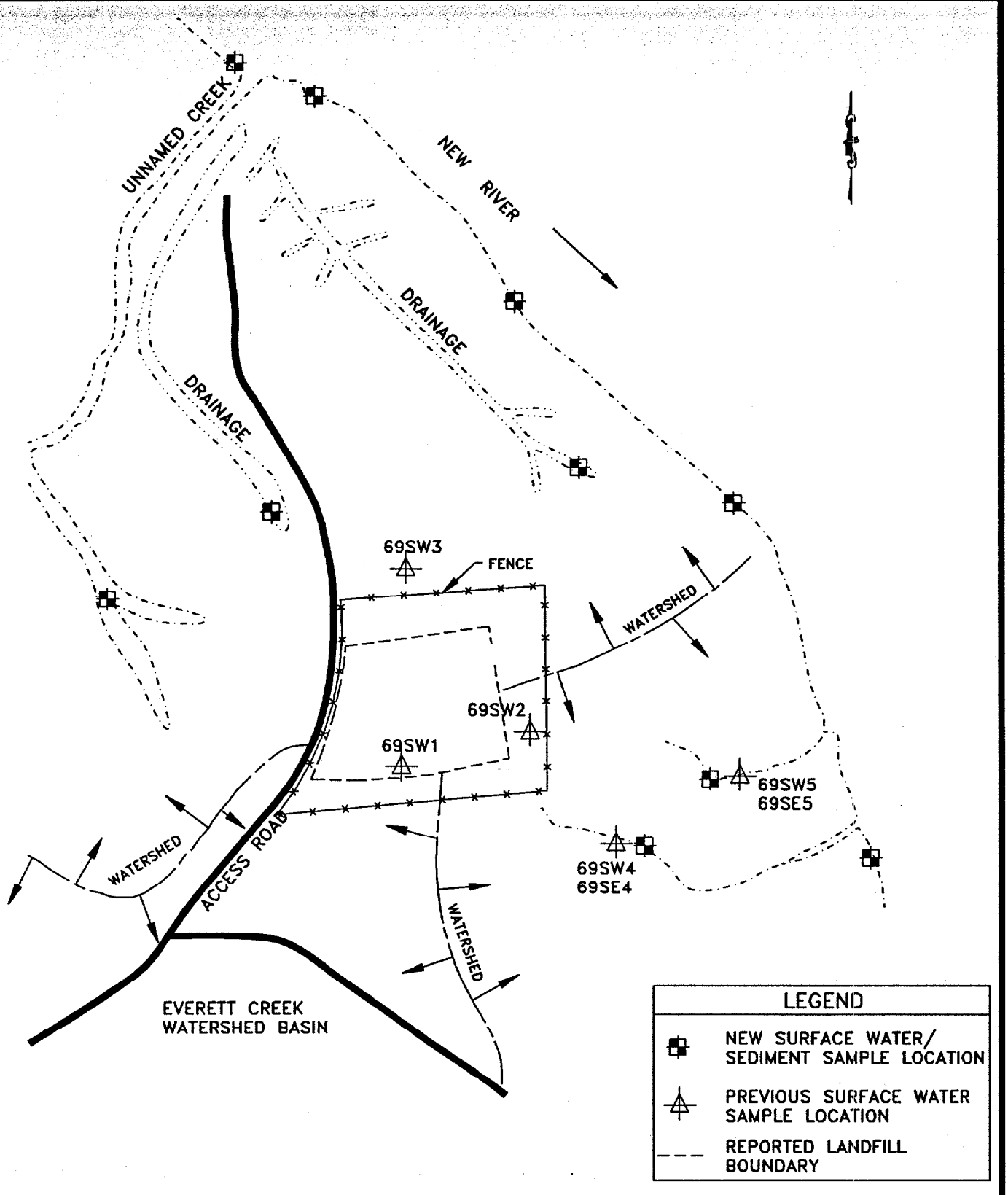


FIGURE 5-5
SITE 69
SURFACE WATER/SEDIMENT SAMPLING LOCATIONS
RIFLE RANGE CHEMICAL DUMP

portions of the site north of Lot 203. These locations will provide data to assess upgradient, downgradient, and adjacent site conditions potentially impacted by surface runoff and/or groundwater discharge.

One surface water sample will be collected from the south bank of the creek and the middle of the creek per sampling station (i.e., 24 surface water samples). A surface (top six inches) and a subsurface (6 to 12 inches bgs) sediment sample will be collected at each sediment sampling station (i.e., 48 sediment samples).

Surface water samples will be collected near the south bank of Wallace Creek by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, then pouring the sample directly into the appropriate sample bottles. Surface water samples collected from the middle of the stream will be collected near the bottom of the stream with a Kemmerer sampler in the deeper stretches of the creek (greater than 3 feet) or by dipping methods at shallower locations (less than 3 feet) along the creek. Sediment samples shall be collected using a hand coring device.

Surface water samples will be collected at each station prior to obtaining the sediment sample. In addition, downstream sample stations will be sampled first, with subsequent samples taken moving upstream. Sampling procedures and related sampling activities are presented in the FSAP.

Ravine Area

Eight surface water and sediment sampling stations will be established along an intermittent stream approximately 200 feet apart in the ravine to assess potential impacts from past disposal practices in this area of Site 6. The sampling locations are depicted on Figure 5-5. If water is present at the time of sampling, a surface water sample shall be collected by dipping methods at each station. A surface (top six inches) and subsurface (6 to 12 inches bgs) sediment sample also will be obtained at each sample station (i.e., 16 sediment samples total). Sediments will be collected with a hand coring device. Sampling procedures are provided in the FSAP.

Analysis

All surface water samples collected from Bear Head Creek, Wallace Creek, or the intermittent steam in the Ravine Area will be analyzed for TCL organics and TAL inorganics via CLP Methods, Level IV data quality. In addition, surface water samples will be analyzed in the field for dissolved oxygen (DO), temperature, specific conductance, and pH (Level II data quality).

All sediment samples will be analyzed for full TCL organics and TAL inorganics (CLP Methods, Level IV data quality), and total organic carbon.

Table 5-1 summarizes the sampling and analytical programs for the surface water and sediment investigation.

5.3.1.7 Aquatic/Ecological Survey

Aquatic/ecological surveys will be conducted in Bear Head Creek and Wallace Creek to evaluate potential ecological impacts from past activities at Site 6. Studies performed in Bear Head Creek also will provide data to assess potential impacts from Site 9, which is located just south of Bear Head Creek. The Aquatic/Ecological Survey will include the collection of benthic macroinvertebrate and fish samples to assess environmental stresses posed by Sites 6 and 9. To assess ecological stresses to the aquatic community posed by stream quality, faunal densities, species richness, and species diversity will be determined for benthic macroinvertebrates at each sampling station. Population statistics will be determined for fish at each sampling station. In addition, three fish samples per station will be collected for subsequent laboratory analysis of whole body parts (one sample) and fillets (two samples). Each fish sample will represent a different species (e.g., first order predator; bass: second order predator; bullhead catfish: third order predator; carp or sucker). All fish analytical samples will be collected for TCL organic and TAL inorganic analysis.

Benthic macroinvertebrate and fish samples will be collected from three, 500-foot stretches (i.e., sampling areas) along Bear Head Creek: upgradient of Sites 6 and 9, adjacent to Sites 6 and 9; and downgradient of Sites 6 and 9 (see Figure 5-5). Four, 500-foot sampling stretches along Wallace Creek have been identified as shown on Figure 5-5. These stations also represent upstream, adjacent, and downstream conditions. A fourth station will be established just downstream of the confluence of Wallace Creek and Bear Head Creek.

Benthic macroinvertebrates will be collected by one of two methods depending on the depth of the water: Ekman grab (shallower water) or Standard Ponar (deeper waters). Fish will be collected at the stations by electroshocking procedures.

Specific sampling and analysis procedures are described in the FSAP.

5.3.1.8 Surface Drum Investigation

A surface drum investigation will be conducted to determine appropriate treatment/disposal methods for the drummed wastes. Nine drums at Drum Area No. 1 (see Figure 5-2) and three drums at Drum Area No. 2 will be sampled and analyzed for RCRA Hazardous Waste Characteristics and TCLP organics and inorganics.

The contents of the drums are unknown at present. Based on information obtained during the site reconnaissance conducted by Baker in September 1991, the drums appear to contain liquid wastes. A vertical composite sample will be collected from each drum after the container is opened. Proper drum opening techniques, as defined in the SAP, will be followed along with Level B health and safety protocol (see the Health and Safety Plan for specific health and safety requirements). The drums will be opened using spark-resistant tools and, if necessary, remote drum opening devices. The sample will be extracted using a Coliwasa sampler.

Sample collection methods, Quality Assurance/Quality Control (QA/QC) samples, decontamination methods, recording, sample handling and preservation, and other sampling-related activities are discussed in detail in the SAP.

5.3.2 Site 9 - Fire Fighting Training Pit

This section presents the field investigation activities for Site 9. These activities will include:

- Surveying
- Soil Investigation
- Groundwater Investigation

The Surface Water/Sediment Investigation and the Aquatic/Ecological Survey for Bear Head Creek, which was discussed in Section 5.3.1.6 and Section 5.3.1.7 of this Work Plan, will

provide data to assess potential impacts from Site 9. Therefore, these investigations will not be repeated in this section.

5.3.2.1 Surveying

Two sampling grids will be established as depicted on Figure 5-6. One grid will encompass the area of the fire training pit and oil/ water separator. The second grid will be established surrounding the aboveground storage tanks.

Both sampling grids will be established at 25 foot spacings. The grid encompassing the pit and oil/water separator will consist of 30 grid points. The grid surrounding the fuel tanks will consist of 11 points (one grid point serves to assess both areas of concern).

All three existing and newly-installed monitoring wells at Site 9 will be surveyed. The vertical accuracy shall be surveyed to 0.01 feet and the horizontal accuracy within 0.1 foot. In addition, other soil sampling stations (i.e., boreholes) that may be added to the field investigation will be surveyed for horizontal control within 1 foot accuracy at this time. Control will be established by use of horizontal and vertical control points near the site that are tied into the North Carolina State Plane Coordinate System. If control points cannot be located, two benchmarks/monuments will be surveyed from the closest USGS (or equivalent) benchmarks. The 1929 msl datum will be used as a reference for the vertical elevation.

5.3.2.2 Soil Investigation

There are two areas of concern within Site 9. As shown on Figure 5-6, the fire training pit and oil water separator area, and the above ground storage tank area. Sampling points at 25 foot spacings will be established at each area as described above in Section 5.3.2.1.

Test borings will be augered and soil samples collected via ASTM Method D1586-84 at each sample station. This will comprise a total of 40 boreholes between the two areas of concern. Samples will be collected from the ground surface (top six inches) and at 5-foot intervals to the top of the water table, which is estimated to be approximately five to ten feet below ground surface across the site. Therefore, it is possible that as many as three samples and no less than two soil samples will be collected from each borehole.

LEGEND

- SOIL BORING (FULL TCL/TAL; CLP METHOD; LEVEL IV; ROUTINE ANALYTICAL TURNAROUND)
- SOIL BORING (TPH ANALYSIS; METHOD 418.1; LEVEL IV; 7-DAY ANALYTICAL TURNAROUND)
- 9GW1 EXISTING MONITORING WELL
- 9GW7D PROPOSED DEEP AQUIFER MONITORING WELL
- 9GW6 PROPOSED SHALLOW AQUIFER MONITORING WELL
- REPORTED OR ESTIMATED GROUNDWATER FLOW DIRECTION

SOURCE: LANTDIV, FEBRUARY 1992

DATE	APRIL 8, 1992
SCALE	1"= 50'
DRAWN	R.E.L.
REVIEWED	R.P.W.
S.O.#	19024-70-SRN
CADD#	9_GW

NORTH

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

SITE 9
GROUNDWATER AND SOIL INVESTIGATION

SCALE 1"= 50' | DATE APRIL 1992

FIGURE No.
5-6

05104AA027

Soil samples will be analyzed for total petroleum hydrocarbons (TPH) via EPA Method 418.1 (Level III data quality). A selected number of samples, as shown on Figure 5-6, will be analyzed for full TCL organics and TAL inorganics in accordance with CLP protocol (Level IV data quality). These locations are nearest to the areas of concern as shown on Figure 5-6.

Total petroleum hydrocarbon results will be received within 7 days following receipt of samples from the laboratory. In the event that samples collected from the outer grid points exhibit elevated levels of TPH (to be determined by EPA and LANTDIV), the grid will be extended horizontal to define the extent of soil contamination. Additional soil samples would be collected as needed to define the extent of soil contamination. The number of samples and expansion of the grid will be determined by LANTDIV in conjunction with their contractor.

Samples analyzed for full TCL organics and TAL inorganics will be received within 28 to 40 days following laboratory receipt of the samples (routine analytical turnaround).

The center borehole from each grid will serve to evaluate engineering parameters. All soil samples from this boring will be analyzed for grain size, moisture density, total TCLP, organic chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, and reactivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction, biological treatment, and solidification/fixation, or off-site treatment and disposal options.

Soil samples also will be collected during the construction of shallow monitoring wells. Samples will be collected just above the water table and just below the water table in the saturated zone. All samples will be analyzed for full TCL organics and TAL inorganics via CLP protocol (Level IV, Routine Analytical Turnaround).

Table 5-1 summarizes the soil sampling program for Site 9.

5.3.2.3 Groundwater Investigation

A Groundwater Investigation will be conducted at Site 9 to assess groundwater quality that may be impacted by ongoing fire training activities. The groundwater investigation will include the construction of monitoring wells, the collection of two rounds of groundwater samples and water level measurements, and aquifer pumping tests.

Monitoring Well Construction

Three shallow monitoring wells were previously installed at Site 9 (wells 9GW1 through 9GW3) as shown on Figure 5-6 to monitor groundwater quality. In order to fully characterize the site area, five additional shallow wells and 1 deep monitoring well will be installed during this RI. The proposed well locations are shown on Figure 5-6. Table 5-2 provides the rationale and purpose for each proposed well location.

All shallow wells will be constructed of 4-inch PVC Casing to a depth of at least 15 feet below the top of the water table. Well screens will be a standard 10 foot length. This well depth and screen length will allow for seasonal fluctuations in the water table and will represent the surficial aquifer at the site. Detailed well construction procedures are provided in the Field Sampling and Analysis Plan (FSAP).

Deep monitoring wells will be constructed of 4-inch PVC casing and screen. These wells will be constructed to a depth below the confining or semi-confining silt or clayey layer in order to monitor the deeper Castle Hayne aquifer. The deep monitoring well could extend as deep as 150 feet. Well construction details are provided in the FSAP.

Groundwater Sampling and Analysis

Two rounds of groundwater samples will be collected from each well. The first round will be collected during this field investigation, which is anticipated to occur in the Summer of 1992. The second round of groundwater samples will be collected in the November or December 1992.

All groundwater samples will be analyzed for full TCL organics and TAL inorganics. TCL volatiles will be analyzed via Method 601/602. All other organic analyses will be analyzed via CLP protocols. Inorganic samples will be analyzed for both total and dissolved constituents. Only total (unfiltered) inorganic analyses will be used in the risk assessment.

Well 9GW5 will also be sampled for analysis of engineering parameters to evaluate process options for treatment of the groundwater. These analytical parameters will include: biological oxygen demand, chemical oxygen demand, total suspended solids (TSS), total dissolved solids (TDS), and total volatile solids (TVS).

Sampling procedures are outlined in the FSAP.

Water Level Measurements

Static water level measurements will be collected from each well during both sampling rounds. Water level measurements shall be collected within a four hour period, if possible. In addition, groundwater levels in at least one shallow and deep well will be recorded continuously with automated data loggers for a 24-hour period to determine tidal influences. Water level measurement techniques are described in the FSAP. Groundwater level data will be used to evaluate groundwater flow direction and aquifer conditions.

Aquifer Testing

Aquifer tests will be conducted to determine shallow and deep aquifer characteristics such as groundwater flow velocity, hydraulic conductivity, and transmissivity. The tests will involve groundwater pumping from monitoring wells with a submersible pump and recording changes in water levels in nearby wells or wells monitoring deeper flow systems.

The design of the site-specific aquifer tests will depend on the preliminary results of the RI. The spacial distribution of the monitoring wells installed during the RI and groundwater analytical data will influence the design of the pumping tests. The selection of pumping durations, location of observation wells (additional observation wells will be necessary), and treatment/disposal options for the extracted groundwater will be determined as field data are evaluated.

A scope of work and schedule for conducting aquifer tests at Site 9 will be prepared when more information is available with respect to present-day site conditions. It is anticipated that the aquifer tests may include the following:

- Selection of pumping and observation wells at each lot or area of concern within Site 9.
- Step drawdown tests on the pumping well to determine the appropriate pumping rate.
- Recording of water levels in the observation wells with a pressure transducer (some water levels in other wells may be recorded manually).
- Short or long-term pumping tests (actual duration would be dependent on stabilization of groundwater conditions).

- Evaluation of data collected to determine aquifer characteristics.

5.3.3 Site 48 - MCAS Mercury Dump

The following RI field investigations will be conducted at Site 48:

- Geophysical Investigation
- Soil Investigation
- Groundwater Investigation
- Surface Water/Sediment Investigation
- Aquatic/Ecological Survey
- Surveying

5.3.3.1 Geophysical Investigation

A Geophysical Investigation will be conducted at Site 48 to identify areas where past disposal practices may have occurred. Electromagnetic terrain conductivity profiling will be used to define areas impacted by previous disposal activities. (This technique was previously discussed in Section 5.3.1.3.) The profiling will be conducted over the alleged disposal area at 10 foot transects as shown on Figure 5-7.

Data generated by this investigation will be evaluated in the field to determine areas of concern where the Soil Investigation will focus.

5.3.3.2 Soil Investigation

The Soil Investigation will focus on two areas: the alleged disposal area behind Building 804, and the edge of the property which borders the New River. The later area should be investigated since one reference did indicate that mercury "was disposed of in woods" behind the building. The only wooded area behind the building is along the edge of the property. If random disposal did occur, it is likely that someone would have disposed of mercury in a wooded/brush area as opposed to a maintained lawn area.

As shown on Figure 5-7, nine boreholes will be augered at approximately 100 foot spacings along the edge of the property that borders the New River. Soil samples will be collected in

CURTIS STREET

SW/SD STATION 7

SW/SD STATION 8

SW/SD STATION 9

HIGH TIDE MARK

LOW TIDE MARK

NEW RIVER

SW/SD STATION 3

SD-1

SD-2

SD-3

GEOPHYSICAL INVESTIGATION TRANSECT LINES (10 foot apart)

48GW2

SW/SD STATION 2

SW/SD STATION 4

48GW4

SD-4

SD-5

SD-6

SUSPECTED DISPOSAL AREA

48GW3

AS804

SD-7

SW/SD STATION 5

SW/SD STATION 10

AS805

AS807

AS872

48GW1

48GW5

SITE 48 BOUNDARY

LONGSTAFF STREET

AS811

SW/SD STATION 6

AS810

SW/SD STATION 1

10

5

5

5

10

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

LEGEND

- SD-1 — PROPOSED SEDIMENT SAMPLING LOCATION STATION 1
- SW/SD STATION 1 — PROPOSED SURFACE WATER/ SEDIMENT SAMPLING LOCATION STATION 1
- 48GW1 — PROPOSED MONITORING WELL LOCATION
- GEOPHYSICAL (GPR/EM) TRANSECTS (10 foot apart)
- PROPOSED SHALLOW SOIL BORING (50 foot apart)
- SURFACE GROUNDWATER FLOW DIRECTION

SOURCE: LANTDIV, FEBRUARY 1992

REVISIONS

DATE	APRIL 8, 1992
SCALE	1"= 50'
DRAWN	R.E.L.
REVIEWED	R.P.W.
S.O.#	19024-70-SRN
CADD#	SITE_48

NORTH

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

BAKER ENVIRONMENTAL,Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

SITE 48
GROUNDWATER/ SOIL/ SURFACE WATER/
SEDIMENT SAMPLING LOCATIONS

SCALE 1"= 50'

DATE APRIL 1992

FIGURE No.
5-7

05104AA03Z

accordance with ASTM Method D1586-84. Samples will be collected from the surface and just above the water table, which should be less than five feet bgs. Samples collected from two of the nine boreholes (the selected boreholes will be directly behind the building) will be analyzed for full TCL organics and TAL inorganics via CLP protocols (Level IV data quality). The remaining samples will be analyzed only for TAL inorganics since the only known problem at this site is related to mercury.

Areas of concern detected during the Geophysical Investigation will be further evaluated under the Soil Investigation. For each area of concern, five boreholes will be augered to the top of the water table. Four boreholes will be augered at the "corners" of each area of concern. The fifth borehole will be augered to the water table in the center of the area of concern. Soil samples will be collected from the surface and just above the water table in accordance with ASTM Method D1586-84. Samples collected from the four "corner" boreholes will be analyzed for full TAL inorganics via CLP protocols (Level IV data quality). Samples collected from the center borehole will be analyzed for full TCL organics and TAL inorganics (CLP Method, Level IV data quality). Routine analytical turnaround will be requested on all samples, except for those samples collected from the center borehole (14 day analytical turnaround).

Soil samples also will be collected during the construction of shallow monitoring wells. Samples will be collected just above the water table and below the water table in the saturated zone so that groundwater results can be correlated with soil conditions. All samples will be analyzed for TAL inorganics via CLP protocol (Level IV, Routine Analytical Turnaround). Samples collected from monitoring well boreholes 48GW1 and 48GW4 will be analyzed for full TCL organics (Level IV, 14-day turnaround) in addition to TAL inorganics.

5.3.3.3 Groundwater Investigation

A Groundwater Investigation will be conducted at Site 48 to assess groundwater quality that may be impacted by the disposal of mercury wastes behind Building 804. The groundwater investigation will include the construction of monitoring wells, the collection of two rounds of groundwater samples and water level measurements, and aquifer pumping tests. In addition, groundwater will be monitored to assess the influence of tides on groundwater flow direction.

Monitoring Well Construction

No monitoring wells have been constructed at this site. In order to fully characterize the site area, five shallow wells will be installed during this RI. The proposed well locations are shown on Figure 5-7. Table 5-2 provides the rationale and purpose for each proposed well location.

All shallow wells will be constructed of 4-inch PVC Casing to a depth of at least 15 feet below the top of the water table. Well screens will be a standard 10 foot length. This well depth and screen length will allow for seasonal or tidal fluctuations in the water table and will represent the surficial aquifer at the site. Detailed well construction procedures are provided in the Field Sampling and Analysis Plan (FSAP).

Groundwater Sampling and Analysis

Two rounds of groundwater samples will be collected from each well. The first round will be collected during this field investigation, which is anticipated to occur in the Summer of 1992. The second round of groundwater samples will be collected in the November or December 1992.

Groundwater samples collected from Wells 48GW1 and 48GW4 will be analyzed for full TCL organics and TAL inorganics. Samples collected from the remaining wells will only be analyzed for TAL inorganics.

TCL volatiles will be analyzed via Method 601/602. All other organic analyses will be analyzed via CLP protocols. Inorganic samples will be analyzed for both total and dissolved constituents. Only total (unfiltered) inorganic analyses will be used in the risk assessment. The second round of sampling may only focus on inorganics if no organic contaminants are detected during the initial sampling round. In the event that organics are detected onsite, the other three wells will be resampled and analyzed for those constituents detected (e.g., volatiles, pesticides, PCBs, etc.).

Well 48GW4 will also be sampled for analysis of engineering parameters to evaluate process options for treatment of the groundwater. These analytical parameters will include: biological oxygen demand, chemical oxygen demand, total suspended solids (TSS), total dissolved solids (TDS), and total volatile solids (TVS).

Sampling procedures are outlined in the FSAP.

Water Level Measurements

Static water level measurements will be collected from each well during both sampling rounds. Water level measurements shall be collected within a one hour period, if possible. Groundwater level data will be used to evaluate groundwater flow direction and aquifer conditions. Groundwater levels in at least three of the five wells will be measured over a 24-hour period to assess the influence of tides on the direction of groundwater flow. Water level measurement techniques are described in the FSAP.

Aquifer Testing

Aquifer tests may be conducted to determine shallow aquifer characteristics such as groundwater flow velocity, hydraulic conductivity, and transmissivity. The tests may involve groundwater pumping from monitoring wells with a submersible pump and recording changes in water levels in nearby wells or wells monitoring deeper flow systems.

The design of the site-specific aquifer tests will depend on the preliminary results of the RI. The spacial distribution of the monitoring wells installed during the RI and groundwater analytical data will influence the design of the pumping tests. The selection of pumping durations, location of observation wells (additional observation wells will be necessary), and treatment/disposal options for the extracted groundwater will be determined as field data are evaluated.

Typical aquifer testing activities have been discussed previously and will not be repeated here (see Section 5.3.2.3).

5.3.3.4 Surface Water/Sediment Investigation

Surface Water and Sediment Investigations will be conducted on the New River and intermittent stream which discharges into the New River to assess human health and ecological impacts associated with these waters. This section outlines the sampling and analytical requirements. Specific sampling procedures can be found in the FSAP.

Intermittent Stream

As shown in Figure 5-7, three surface water and sediment sampling stations have been identified to characterize upgradient site conditions and potential impacts from Site 48 (i.e., Stations SW/SD 1 through 3 on Figure 5-7). One surface water sample will be collected from the bank of the intermittent stream at each sampling station. A surface (top six inches) and a subsurface (6 to 12 inches bgs) sediment sample will be collected at each station (i.e., 6 sediment samples total). Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, then pouring the sample directly into the appropriate sample bottles. All surface water and sediment samples will be analyzed for TAL inorganics (Level IV, Routine turnaround time). If organics are detected in onsite soil and/or groundwater samples, surface water and sediment samples also will be analyzed for organics.

Surface water samples will be collected at each station prior to obtaining the sediment sample. In addition, downstream sample stations will be sampled first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device. The FSAP discusses both surface water and sediment sampling activities.

New River Estuary

Surface water and sediment samples will be obtained from the "marsh" area, and along the New River upgradient, adjacent, and downgradient areas from Site 48 as shown on Figure 5-7. Samples will be taken along the banks of the New River near the site as well as offshore locations to assess the potential migration of contaminants due to tidal affects. Samples collected from the marsh area also would be used to assess tidal affects on the migration and transport of sediments.

As shown on Figure 5-7, 12 surface water and sediment stations have been identified in the New River (Stations SW/SD 4 through SW/SD10). In addition, seven sediment stations along the New River (Stations SD1 through SD7) have been proposed to better characterize the sediments nearest to the site.

Sediment samples will be collect from the surface (top six inches) and subsurface (6 to 12 inches bgs). Surface water samples will be collected from the edge of the river or intermittent stream at each surface water/sediment sampling station. At those locations within the marsh area or offshore areas (Stations SW8, SW9, SW10, SW14, and SW15), two surface water samples will be obtained: one from the surface and one from the bottom of the river or marsh.

All surface water and sediment samples will be analyzed for TAL inorganics. Surface water and sediment samples collected from sample locations SW/SD4, SW/SD5, and SW/SD9 will be analyzed for full TCL organics in addition to TAL inorganics. In the event that onsite soil and/or groundwater samples exhibit organic contamination, all surface water and sediment samples will be analyzed for those classes of contaminants (e.g., volatiles, pesticides, etc.) detected onsite. CLP methods will be employed on all surface water and sediment samples. All samples will be analyzed in accordance with Level IV QA/QC.

Sampling details are provided in the FSAP.

5.3.3.5 Aquatic/Ecological Survey

Aquatic/Ecological Surveys will be conducted in the New River, including the marsh area, to evaluate potential ecological impacts from past activities at Site 48. The Aquatic/Ecological Survey will include the collection of benthic macroinvertebrate and fish samples to assess environmental stresses posed by Sites 48. Benthic, fish, and shellfish collection stations have been identified on Figure 5-8. The collection stations represent upgradient, adjacent, and downgradient sampling locations. Although not shown on Figure 5-8, a reference station from a similar waterway will be included in this investigation for comparison purposes. The reference station will be identified in conjunction with the DEHNR and the U.S. Fish and Wildlife.

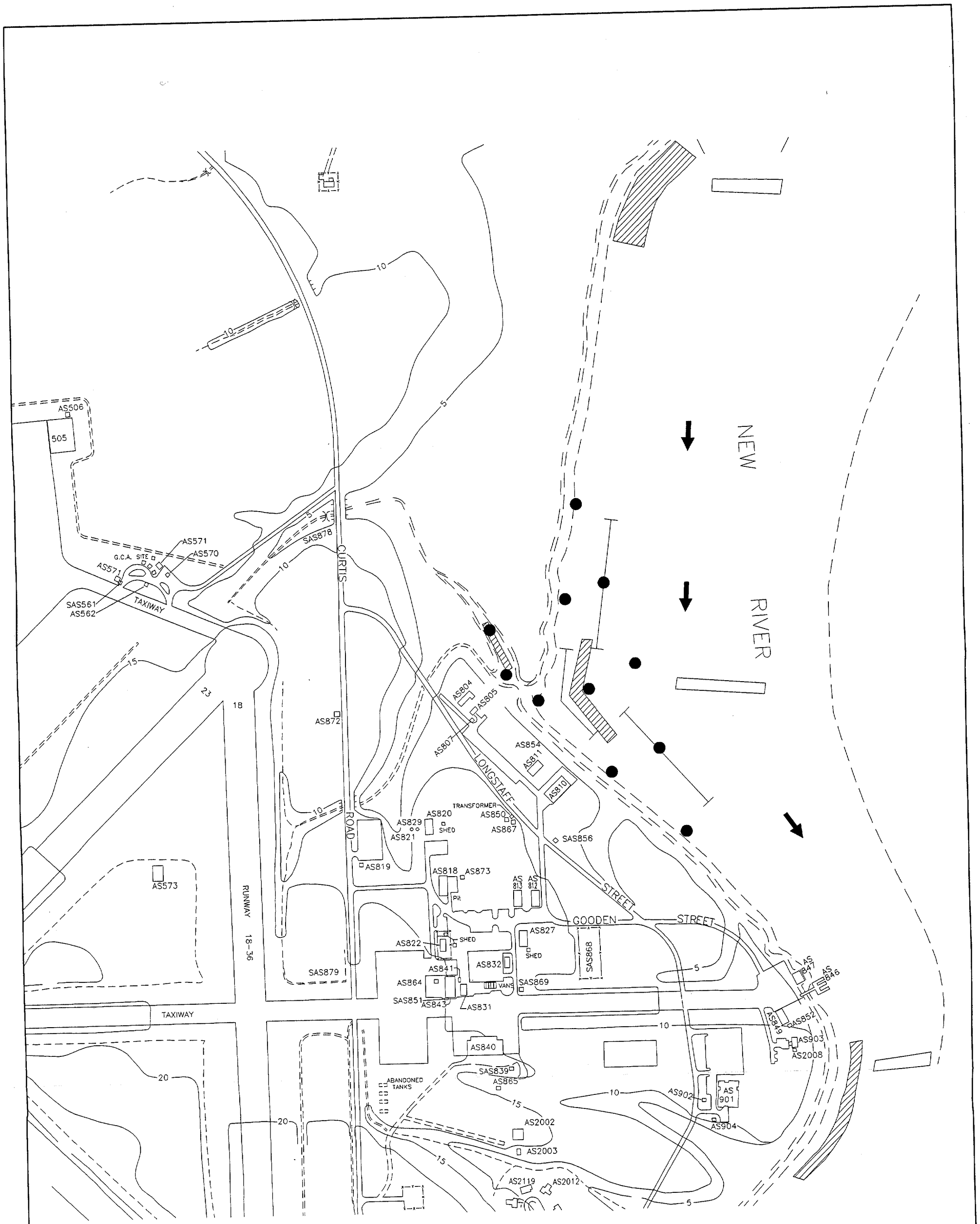
Ecological stresses to the aquatic community posed by water or sediment quality will be assess by calculating faunal densities, species richness, and species diversity for benthic macroinvertebrates at each sampling station. Population statistics will be determined for fish at each sampling station. In addition, three fish and three shellfish samples per station will be collected for subsequent laboratory analysis of whole body parts (fish only) and fillets. Each fish sample will represent a different species as discussed previously in Section 5.3.1.7. All fish and shellfish samples will be analyzed for TAL inorganics. Approximately 10 percent of the fish and shellfish will also be analyzed for TCL organics. However, if organics are detected onsite, all fish and shellfish samples will be analyzed for those classes of compounds detected onsite in addition to TAL inorganics.

Benthic macroinvertebrates will be collected by one of two methods depending on the depth of the water: Ekman grab (shallower water) or Standard Ponar (deeper waters). Fish will be collected at the stations by electroshocking procedures near the shoreline or in the marsh area, or by gill nets in the more open (and deeper) waters.

Specific sampling and analysis procedures are described in the FSAP.

5.3.3.6 Surveying

All newly-installed monitoring wells at Site 48 will be surveyed. The vertical accuracy shall be surveyed to 0.01 feet and the horizontal accuracy within 0.1 foot. In addition, other soil sampling stations (i.e., boreholes) that may be added to the field investigation will be surveyed for horizontal control within 1 foot accuracy at this time. Control will be established by use of horizontal and vertical control points near the site that are tied into the North Carolina State Plane Coordinate System. If control points cannot be located, two benchmarks/monuments



LEGEND

- ELECTROSHOCKING FISH COLLECTION AREA
- FISH COLLECTION AREA- GILL NETS
- BENTHIC COLLECTION STATION
- BENTHIC/SHELLFISH COLLECTION AREAS
- SURFACE WATER FLOW DIRECTION

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)
1 inch = 200 ft.

SOURCE: LANTDIV, FEBRUARY 1992

REVISIONS	
DATE	APRIL 8, 1992
SCALE	1"= 200'
DRAWN	R.E.L.
REVIEWED	R.P.W.
S.O.#	19024-50-SRN
CADD#	AQUA_48

NORTH

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker Environmental, Inc.

SITE 48
AQUATIC INVESTIGATION SAMPLING LOCATIONS

SCALE 1"= 200' DATE APRIL 1992

FIGURE No 5-8

05104AA04Z

will be surveyed from the closest USGS (or equivalent) benchmarks. The 1929 msl datum will be used as a reference for the vertical elevation.

5.3.4 Site 69 - Rifle Range Chemical Dump

Historical information has determined that there is a high probability that chemical agents are buried at Site 69, based on input from the U.S. Army Technical Escort Unit and THAMA personnel. Discussions with these personnel have indicated that exploratory investigations to determine the presence of chemical agents are not practical since there is no immediate danger to life or health. Additionally, if investigations are conducted to confirm the presence of chemical agents, and if agents are encountered, they would need to be removed and handled appropriately. At this time, there is no regulated Army Surety storage facility that could store the waste since the waste would be classified as a hazardous waste. None of the Army Surety storage facilities are permitted to store hazardous waste.

A Remedial Investigation will be conducted at Site 69 in order to better define the boundaries of the disposal areas, and to evaluate off-site groundwater quality.

The following investigations will be conducted at Site 69:

- Surveying
- Geophysical Investigation
- Groundwater Investigation
- Soil Investigation
- Surface Water and Sediment Investigation
- Aquatic/Ecological Assessment

5.3.4.1 Surveying

All existing (eight) and newly-installed monitoring wells at Site 69 will be surveyed. The vertical accuracy shall be surveyed to 0.01 feet and the horizontal accuracy within 0.1 foot. In addition, other soil sampling stations (i.e., boreholes) that may be added to the field investigation will be surveyed for horizontal control within 1 foot accuracy at this time. Control will be established by use of horizontal and vertical control points near the site that are tied into the North Carolina State Plane Coordinate System. If control points cannot be

located, two benchmarks/monuments will be surveyed from the closest USGS (or equivalent) benchmarks. The 1929 msl datum will be used as a reference for the vertical elevation.

Transect lines for the geophysical investigation also will be surveyed at 20 foot spacings across the site area and referenced to existing monitoring wells or other "permanent" on-site structures.

5.3.4.2 Geophysical Investigation

A geophysical investigation will be conducted to:

- Identify subsurface anomalies that may be associated with buried drums or bulk wastes.

- Identify waste disposal boundaries associated with past disposal practices.

The geophysical investigation will involve the use of electromagnetic terrain conductivity profiling, and ground penetrating radar techniques to obtain the required information. The investigation will be conducted along transects across the site at 20-foot spacings to collect information to adequately define subsurface features. Data obtained during this investigation will be used to define suspected drum/waste disposal areas, and any area not suspected of containing buried wastes. Once these areas are defined, the information will be evaluated to assess the potential contents and area of disposal. These areas will be identified in the field with wooden stakes and surveyed.

Geophysical techniques proposed for this site are further described in the SAP.

5.3.4.3 Groundwater Investigation

The Groundwater Investigation at Site 69 will involve characterizing the extent of off-site groundwater contamination in the shallow aquifer. In addition, potential contamination to the deep aquifer will be assessed.

In order to assess the extent of off-site volatile organic contamination in the shallow aquifer, shallow monitoring wells will be installed downgradient from known areas of groundwater contamination. To help locate the extent of this contamination, shallow groundwater samples

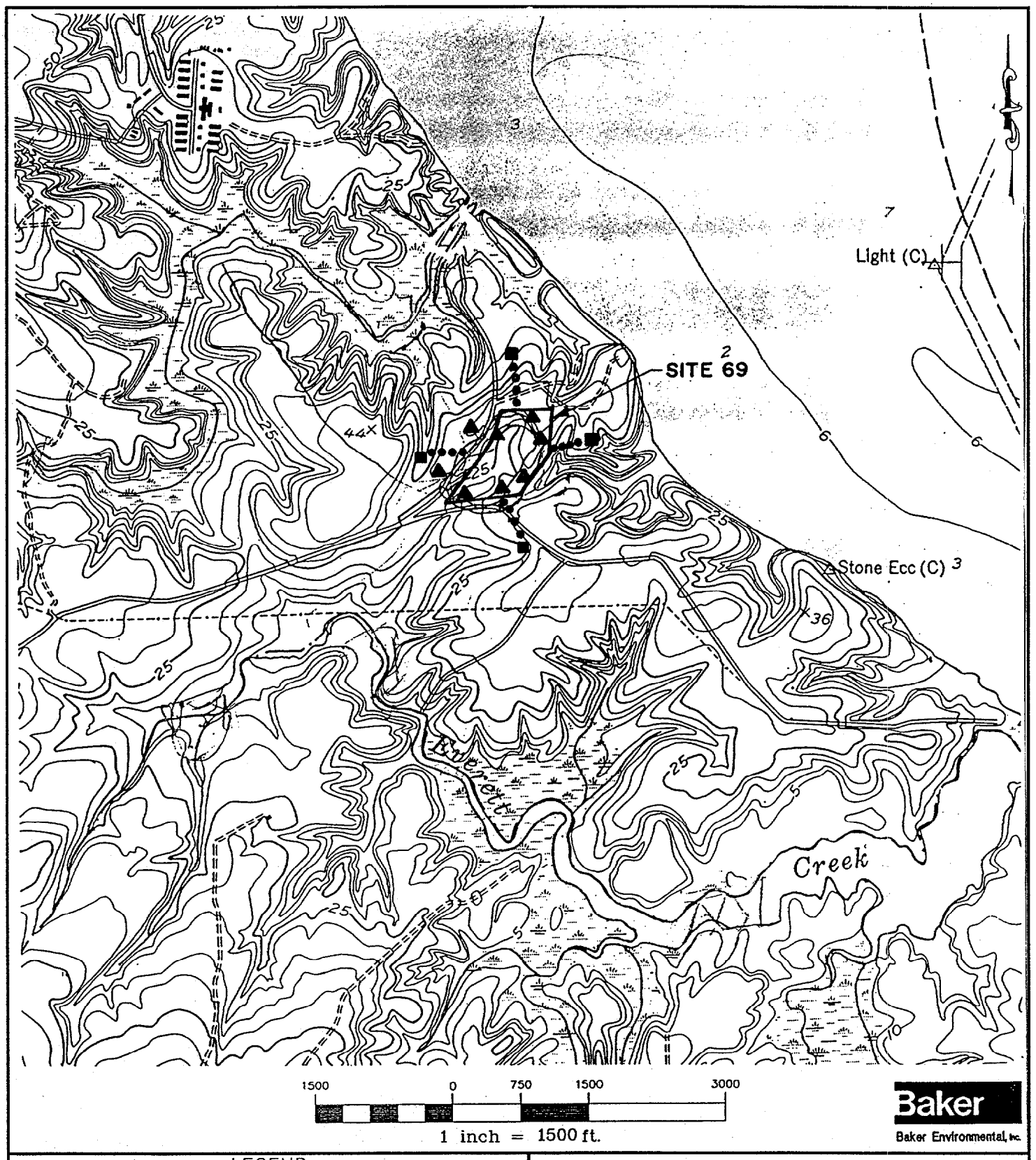
will be obtained from borings via "Hydropunching". Boreholes will be advanced at 50 foot spacings from the site beginning at the site fence. This line of boreholes will advance from the northern, southern, eastern, and western borders. Four boreholes will be augered in each direction from the site (i.e., 16 boreholes). The boreholes will be augered to a depth of approximately 20 feet and a sample of the groundwater will be obtained for volatile organic analysis (EPA Method 601/602, Level II data quality). The results will be provided within 24 hours following receipt of the sample by the laboratory. If the outermost borehole groundwater sample exhibits volatile organics, four additional boreholes will be advanced and a groundwater sample will be obtained via Hydropunching. This will continue until the extent of contamination in the shallow aquifer can be defined.

When the extent of shallow groundwater contamination is defined by this method, four downgradient monitoring wells will be constructed (one well in each direction from the site). This scheme is depicted in Figure 5-9. All four monitoring wells will be constructed of 4-inch PVC casing and screen. The screen shall be Schedule 40 and ten feet in length. The wells shall be constructed to a depth of approximately 20 to 25 feet bgs so that the well screen is set at least 10 feet below the top of the water table. The water table at Site 69 was reported to be approximately 10 to 15 feet bgs in most cases.

Two rounds of groundwater samples will be collected from the eight existing wells and four proposed shallow wells. All groundwater samples will be analyzed for TCL organics and TAL inorganics using CLP protocols. Chemical surety compound (CSM) degradation products also will be analyzed in groundwater samples through a certified surety laboratory. A list of target CSM degradation products generally analyzed when surety is suspected are given on Tables 5-3 and 5-4.

Most of the compounds are analyzed by gas chromatography/mass spectrometry (GC/MS). If arsenicals are suspected, the first step is to analyze for arsenic using a sensitive technique such as graphite furnace atomic adsorption spectroscopy. If arsenic is detected above normal background levels, characterization of the organo-arsenic compounds is performed by high performance liquid chromatography (HPLC).

Table 5-3 lists the compounds that require derivatization prior to GC/MS analysis.



LEGEND

- PROPOSED HYDROPUNCH LOCATION
- EXISTING SHALLOW WELL LOCATION
- PROPOSED SHALLOW WELL LOCATION

SOURCE: U.S.G.S. TOPOGRAPHIC MAP

FIGURE 5-9
SITE 69
SOIL AND GROUNDWATER
INVESTIGATION
MCB CAMP LEJEUNE, NORTH CAROLINA

TABLE 5-3

TARGET CHEMICAL SURETY COMPOUND (CSM) DEGRADATION COMPOUNDS DERIVATIZED PRIOR TO GC/MS ANALYSIS

thiodigylcol

hydroxyacetophenone

methylphosphonic acid

isopropylmethylphosphonic acid

ethylmethylphosphonic acid

Triodiglycol is a decomposition product of the mustard gas constituents. Hydroxyacetophenone is a compound involved in mustard synthesis. The other compounds are decomposition products of GA, GB, GD and/or VX (nerve agents).

Table 5-4 lists those target CSM degradation products which are analyzed by GC/MS using the Method 8270 protocol for extractable semivolatile organics.

TABLE 5-4

TARGET CHEMICAL SURETY COMPOUND (CSM) DEGRADATION COMPOUNDS ANALYZED USING THE METHOD 8270 PROTOCOL

DMMP

DIMP

Acetophenone

Chloroacetophenone

Bis (2-Chloroethyl) Disulfide

Bis (2-Chloroethyl) Trisulfide

Hexachloroethane

Dithiane

The first two compounds are related to the G agents (nerve agents) and the remainder of the compounds are related to mustard synthesis or degradation.

Water level measurements and in-situ permeability tests will be conducted on all monitoring wells (see the SAP for specific details). In addition, groundwater levels in at least one shallow and deep well will be recorded continuously with automated data loggers for a 24-hour period to determine tidal influences.

Sampling procedures, decontamination, recording, and other sampling related activities are described in detail in the SAP.

5.3.4.4 Soil Investigation

A soil investigation will be conducted off site to assess potential migration of contaminants from Site 69. Soil samples will be collected from the borings augered during Hydropunching. Soil samples will be collected from the surface (top six inches) and from the bottom of the borehole in accordance with ASTM Method D1586-84. All soil samples will be analyzed for TCL organics and TAL inorganics (CLP protocols, Level IV data quality). In addition, soil samples will be analyzed for those CSM constituents identified in Tables 5-3 and 5-4 (Level III data quality).

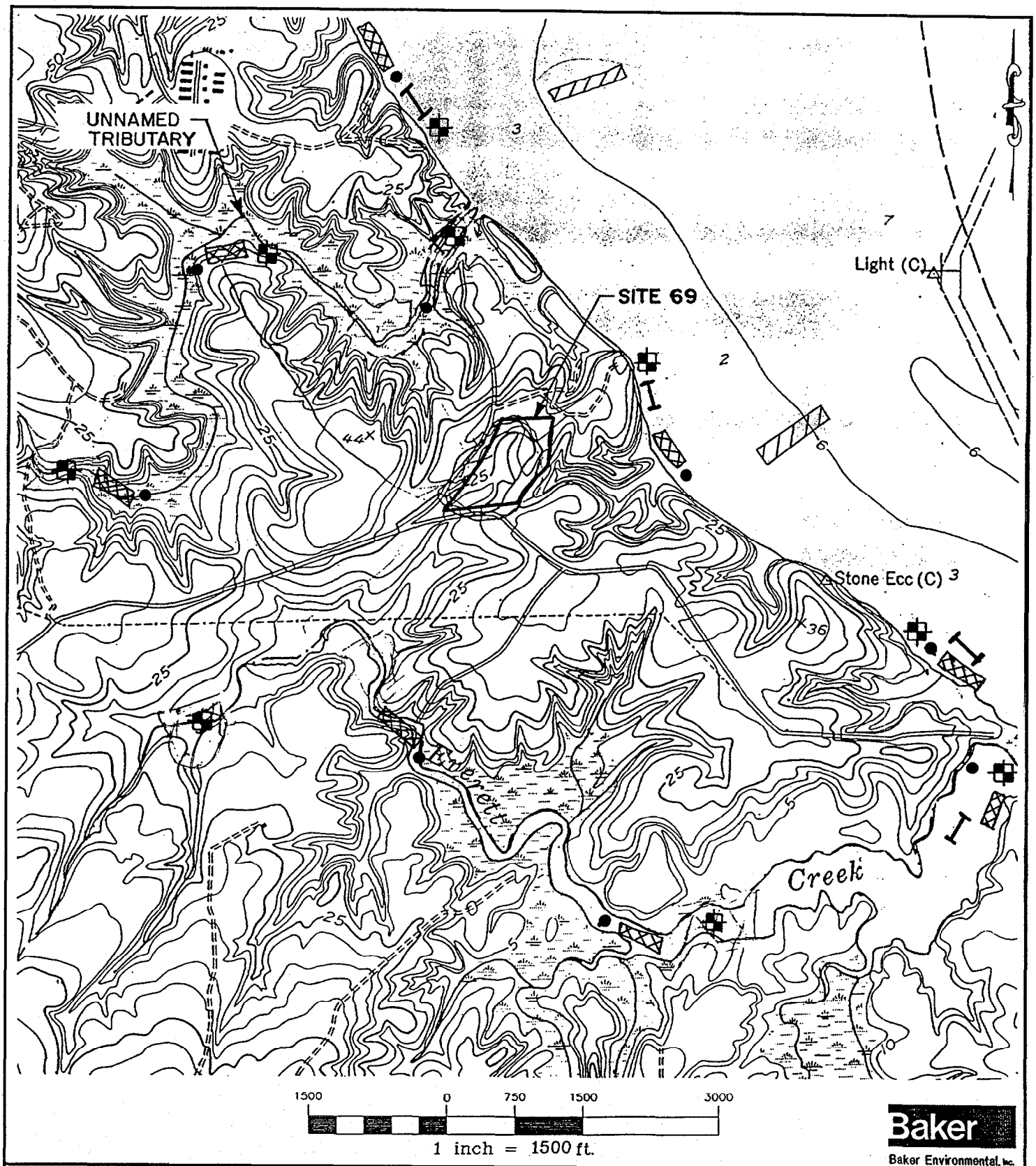
During the drilling of monitoring well boreholes, soil samples shall be collected just above and just below the water table during the drilling of monitoring well boreholes to correlate groundwater results with subsurface soil conditions. Samples collected below the water table (saturated soil conditions) will provide analytical data to evaluate migration potentials in the risk assessment. All soil samples will be analyzed for full TCL organics and TAL inorganics via CLP Methods (Level IV data quality).

5.3.4.5 Surface Water/Sediment Investigation

Surface Water and Sediment Investigations will be conducted on the New River, Everett Creek, and the intermittent stream which discharges into the New River (north and south of the site) to assess human health and ecological impacts associated with these waters and sediment. This section outlines the sampling and analytical requirements. Specific sampling procedures can be found in the FSAP.

Intermittent Streams

As shown in Figure 5-10, three surface water and sediment sampling stations have been identified in each unnamed stream located north of the site to characterize surface water and sediment quality. One surface water sample will be collected from the center of the



LEGEND

- BENTHIC GRAB STATIONS
- PROPOSED SURFACE WATER/SEDIMENT SAMPLING LOCATION
- PROPOSED ELECTROSHOCKING LOCATION
- PROPOSED GILL NET LOCATION

SOURCE: U.S.G.S. TOPOGRAPHIC MAP

FIGURE 5-10
SITE 69 – SURFACE WATER/SEDIMENT INVESTIGATION AND AQUATIC SURVEY LOCATIONS
MCB CAMP LEJEUNE, NORTH CAROLINA

intermittent stream at each sampling station. A surface (top six inches) and a subsurface (6 to 12 inches bgs) sediment sample will be collected at each station (i.e., 12 sediment samples total). Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, then pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample. In addition, downstream sample stations will be sampled first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device.

All surface water and sediment samples will be analyzed for full TCL organics and TAL inorganics in accordance with CLP protocols (Level IV data quality).

The FSAP discusses both surface water and sediment sampling activities.

New River

Surface water and sediment samples will be obtained from the New River upgradient, adjacent, and downgradient areas from Site 69 as shown on Figure 5-10. Samples will be taken along the banks of the New River. As shown on Figure 5-10, three surface water and sediment stations have been identified in the New River (Stations SW/SD 7 through SW/SD9). Sediment samples will be collect from the surface (top six inches) and subsurface (6 to 12 inches bgs) using a hand coring device. Surface water samples will be collected from the edge of the river at each surface water/sediment sampling station.

All surface water and sediment samples will be analyzed for full TCL organics and TAL inorganics in accordance with CLP protocols (Level IV data quality).

Sampling details are provided in the FSAP.

Everett Creek

As shown in Figure 5-10, three surface water and sediment sampling stations have been identified in Everett Creek to characterize surface water and sediment quality. One surface water sample will be collected from the center of the intermittent stream at each sampling station. A surface (top six inches) and a subsurface (6 to 12 inches bgs) sediment sample will

be collected at each station (i.e., 12 sediment samples total). Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, then pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample. In addition, downstream sample stations will be sampled first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device.

All surface water and sediment samples will be analyzed for full TCL organics and TAL inorganics in accordance with CLP protocols (Level IV data quality).

The FSAP discusses both surface water and sediment sampling activities.

5.3.4.6 Aquatic/Ecological Survey

Aquatic/Ecological Surveys will be conducted in the New River, Everett Creek, and the unnamed stream to the north of Site 69 to evaluate potential ecological impacts from past activities at Site 69. The Aquatic/Ecological Survey will include the collection of benthic macroinvertebrate samples to assess environmental stresses posed by Sites 69. Fish and shellfish samples will also be collected if site-related contaminants are detected in surface water or sediment samples. Benthic, fish, and shellfish collection stations have been identified on Figure 5-10. The collection stations represent upgradient, adjacent, and downgradient sampling locations.

Benthic macroinvertebrates will be collected by one of two methods depending on the depth of the water: Ekman grab (shallower water) or Standard Ponar (deeper waters). Fish will be collected at the stations by electroshocking procedures in shallower waters or by gill nets in the more open (and deeper) waters.

Specific sampling and analysis procedures are described in the FSAP.

If surface waters or sediments are contaminated with site-related constituents, three fish and three shellfish samples from each sample station will be analyzed for those site-related constituents detected onsite in accordance with EPA Standard Procedures for the Conduct of Marine Environmental Sampling and Analysis (ERL, 1991).

Table 5-1 summarizes the sampling and analytical requirements of this program.

5.4 Task 4 - Sample Analysis and Validation

This task involves efforts relating to the following post-field sampling activities:

- Sample Management
- Laboratory Analysis
- Data Validation

Sample management activities involve coordination with subcontracted laboratories, tracking of samples submitted for analysis, tracking of analyses received, and tracking of samples submitted and received from a third party validator. Sample management also involves resolving potential problems (reanalysis, resubmission of information, etc.) between Baker, the laboratory, and the validator.

Laboratory analysis begins when the samples are shipped from the field and received by the laboratory. The cost for analysis are included as part of this task. Subcontracted laboratories under a Baker Basic Ordering Agreement will be utilized.

Validation begins when the "raw" laboratory data is received by the validator from Baker. Baker will first receive the data from the laboratory, log it into a database for tracking purposes, and then forward it to the validator. A validation report will be expected within three weeks following receipt of laboratory data packages (Level IV) by the validator. Level IV data will be validated per the CLP criteria as outlined in the following documents:

- EPA, Hazardous Site Control Division, Laboratory Data Validation Functional Guidelines for Evaluating Pesticides/PCB Analyses, R-582-5-5-01, May 28, 1985.

- EPA, Hazardous Site Control Division, Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses, R-582-5-5-01, May 28, 1985.

- EPA, Office of Emergency and Remedial Response, Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, 1985.

5.5 Task 5 - Data Evaluation

This task involves efforts related to the data once it is received by the laboratory and validated. It also involves the evaluation of any field-generated data including: water level measurements, in-situ permeability tests, test boring logs, test pit logs, and other field notes. Efforts under this task will include the tabulation of validated data and field data, generation of test boring logs and monitoring well construction logs, generation of geologic cross-section diagrams, and the generation of other diagrams associated with field notes or data received from the laboratory (e.g., sampling location maps, isoconcentration maps).

5.6 Task 6 - Risk Assessment

This section of the Work Plan will serve as the guideline for the baseline risk assessments (BRAs) to be conducted for MCB Camp Lejeune during the Remedial Investigation.

Baseline risk assessments evaluate the potential human health and/or ecological impacts that would occur in the absence of any remedial action. The risk assessment will provide the basis for determining whether or not remedial action is necessary and the justification for performing remedial actions.

The risk assessments will be performed in accordance with EPA guidelines. The primary documents that will be utilized include:

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A), EPA 1989.

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), EPA 1991.

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives), EPA 1991.

- Risk Assessment Guidance for Superfund: Volume II, Environmental Evaluation Manual, EPA 1989.

- Supplemental Guidance to RAGS: Standard Default Values, EPA 1991a.
- Superfund Exposure Assessment Manual, EPA 1988.
- Exposure Factors Handbook, EPA 1989b.
- Guidance for Data Usability in Risk Assessment,EPA 1990.

EPA Region IV will be consulted for Federal guidance, and the North Carolina Department of Environment, Health, and Natural Resources will be consulted for guidance in the State of North Carolina.

The technical components of the BRA are contaminant identification, exposure assessment, toxicity assessment, and risk characterization. The objectives of the risk assessment process can be accomplished by:

- Characterizing the toxicity and levels of contaminants in relevant media (e.g., groundwater, surface water, soil, sediment, air, and biota).
- Characterizing the environmental fate and transport mechanisms within specific environmental media.
- Identifying potential human and/or environmental receptors.
- Identifying potential exposure routes and the extent of the actual or expected exposure.
- Defining the extent of the expected impact or threat.
- Identifying the levels of uncertainty associated with the above items.

As outlined in the Scope of Work,the quantitative BRAs to be performed at MCB Camp Lejeune for Sites 6, 9, 48, and 69 are to utilize all available data to date that has been properly validated in accordance with EPA guidelines plus all data to be collected from additional sampling during this RI.

5.6.1 Human Health Evaluation Process

5.6.1.1 Site Location and Characterization

A background section will be presented at the beginning of each risk assessment to provide an overview of the characteristics of each site. This section will provide a general site description and the site-specific chemicals as discussed in past reports. The physical characteristics of the site and the geographical areas of concern will be discussed. This site description will help to characterize the exposure setting.

5.6.1.2 Data Summary

Because decisions regarding data use may influence the resultant risk assessment, careful consideration must be given to the treatment of those data. For purposes of risk evaluation, the sites at MCB Camp Lejeune may be partitioned into zones or operable units for which chemical concentrations will be characterized and risks will be evaluated. Sites will be grouped into operable units if they are close to one another, have similar contamination, and/or may impact the same potential receptors. In selecting data to include in the risk assessment, the objective is to characterize, as accurately as possible, the distribution and concentration of chemicals in each operable unit.

Data summary tables will be developed for each medium sampled (e.g., surface water, sediment, groundwater, soil). Each data summary table will indicate the frequency of detection, observed range of concentrations, and the means and upper 95 percent confidence limit value for each contaminant detected in each medium. The arithmetic or geometric mean and the upper 95 percent confidence limit of that mean will be used in the summary of potential chemical data. The selection of arithmetic or geometric means will depend on whether the sample data are normally or log- normally distributed. In the calculation of the mean, concentrations presented as "ND" (nondetect) will be incorporated at one-half the sample detection limit.

5.6.1.3 Identifying Chemicals of Potential Concern

The chemical data will be evaluated to identify site-specific chemicals on which to focus subsequent efforts in the risk assessment process. For example, although numerous chemicals may be detected in surface water or soil samples, they may be unrelated to contamination (i.e.,

they may be naturally occurring at the levels observed), and/or they may be of relatively little concern toxicologically, such as iron, magnesium, calcium, potassium, and sodium. Therefore, if sufficient background samples are collected, a statistical comparison between background and site data will be performed to determine whether site concentrations exceeded background at a statistically significant level (e.g., 95 percent confidence).

All of the available sample data will undergo review upon initiation of the risk assessment. Common laboratory contaminants such as acetone, methylene chloride, phthalate esters, toluene, and methyl ethyl ketone will be addressed only if concentrations are 10 times greater than the corresponding blanks. In addition, chemicals that are not common laboratory contaminants will be evaluated if they are greater than five times the laboratory blank. The number of chemicals analyzed in the risk assessment will be a subset of the total number of chemicals detected at a site based on the elimination criteria discussed previously.

Tables will be prepared that list chemical concentrations for all media by site. Data will be further grouped according to organic and inorganic species within each table.

5.6.1.4 Exposure Assessment

The objectives of the exposure assessment at MCB Camp Lejeune will be to characterize the exposure setting, identify exposure pathways, and quantify the exposure. When characterizing the exposure setting, the potentially exposed populations will be described. The exposure pathway will identify: the source and the mechanism of medium for the released chemical (e.g., groundwater), the point of potential human contact with the contaminated medium, and the exposure route(s) (e.g., ingestion). The magnitude, frequency, and duration for each exposure pathway identified will be quantified during this process.

The identification of potential exposure pathways at the four sites will include the activities described in the subsections that follow.

Analysis of the Probable Fate and Transport of Site- Specific Chemicals

To determine the environmental fate and transport of the chemicals of concern at the site, the physical/chemical and environmental fate properties of the chemicals will be reviewed. Some of these properties include volatility, photolysis, hydrolysis, oxidation, reduction, biodegradation, accumulation, persistence, and migration potential. This information will

assist in predicting potential current and future exposures. It will help in determining those media that are currently receiving site-related chemicals or may receive site-related chemicals in the future. Sources that may be consulted in obtaining this information include computer databases (e.g., AQUIRE, ENVIROFATE), as well as the open literature.

The evaluation of fate and transport may be necessary where the potential for changes in future chemical characteristics is likely and for those media where site-specific data on the chemical distribution is lacking.

Identification of Potentially Exposed Human Populations

Human populations, that may be potentially exposed to chemicals at the MCB Camp Lejeune, include base personnel and their families, base visitors, and on-site workers and recreational fishermen/women. The Base Master Plan will be consulted to confirm or modify these potential exposures. Nonworking residents who might be exposed to site-specific chemicals could include spouses and/or children of base personnel and resident workers. Resident and nonresident workers could be exposed to chemicals as they carry out activities at any of the sites located at MCB Camp Lejeune. The list of potential receptors and pathways to be evaluated will be refined during discussions with regulators prior to performing the BRA.

Identification of Potential Exposure Scenarios Under Current and Future Land Uses

The exposure scenarios will be developed after consulting with the Base Master Plan, EPA and the State of North Carolina. Generally, exposure pathways will be considered preliminarily as follows:

- Soil Pathway
  - Direct ingestion (worker, resident, recreational fishermen/women)
  - Inhalation of dust (worker, resident)
  - Dermal contact (worker, resident, recreational fishermen/women)
- Sediment Pathway
  - Dermal contact (worker, resident, recreational fishermen/women)
  - Ingestion of shellfish (worker, resident, recreational fishermen/women)
- Surface Water
  - Dermal contact (worker, resident, recreational fishermen/women)
  - Ingestion of contaminated fish (worker, resident, recreational fishermen/women)

- Groundwater
  - Direct ingestion (base personnel, on-site residents, on-site workers, visitors)
  - Inhalation (base personnel, on-site residents, on-site workers, visitors)

Exposure Point Concentrations

After the potential exposure points and potential receptors have been defined, exposure point concentrations must be calculated. The chemical concentrations at these contact points are critical in determining intake and, consequently, risk to the receptor. The data from site investigations will be used to estimate exposure point concentrations.

The means and the upper 95 percent confidence limits of the means will be used throughout the risk assessment. If the data are log- normally distributed, the means will be based on the geometric mean rather than the arithmetic mean. In cases where maximum concentrations are exceeded by upper 95 percent confidence limit, the maximum concentrations will be used.

Exposure doses will be estimated for each exposure scenario from chemical concentrations at the point of contact by applying factors that account for contact frequency, contact duration, average body weight, and other route-specific factors such as breathing rate (inhalation). These factors will be incorporated into exposure algorithms that convert the environmental concentrations into exposure doses. Intakes will be reported in milligrams of chemical taken in by the receptor (i.e., ingested, inhaled, etc.) per kilogram body weight per day (mg/kg-day). Intakes for potentially exposed populations will be calculated separately for the appropriate exposure routes and chemicals.

5.6.1.5 Toxicity Assessment

Toxicity values (i.e., numerical values derived from dose-response toxicity data for individual compounds) will be used in conjunction with the intake determinations to characterize risk. Toxicity values may be taken or derived from the following sources:

- Integrated Risk Information System (IRIS, 1992) - The principal toxicology database, which provides updated information from EPA on cancer slope factors, reference doses, and other standards and criteria for numerous chemicals.

- Health Effects Assessment Summary Tables (EPA, 1991b) - A tabular summary of noncarcinogenic and carcinogenic toxicity information contained in IRIS.

For some chemicals, toxicity values (i.e., reference doses) may have to be derived if the principal references previously mentioned do not contain the required information. These derivations will be provided in the risk assessment for review by EPA Region IV. The toxicity assessment will include a brief description of the studies on which selected toxicity values were based, the uncertainty factors used to calculate noncarcinogenic reference doses (RfDs), the EPA weight-of-evidence classification for carcinogens, and their respective slope factors.

5.6.1.6 Risk Characterization

Risk characterization involves the integration of exposure doses and toxicity information to quantitatively estimate the risk of adverse health effects. Quantitative risk estimates based on the reasonable maximum exposures to the site contaminants will be calculated based on available information. For each exposure scenario, the potential risk for each chemical will be based on intakes from all appropriate exposure routes. Carcinogenic risk and noncarcinogenic hazard indices are assumed to be additive across all exposure pathways and across all of the chemicals of concern for each exposure scenario. Potential carcinogenic risks will be evaluated separately from potential noncarcinogenic effects, as discussed in the following subsections.

Carcinogenic Risk

For the potential carcinogens that are present at the site, the carcinogenic slope factor (q_1^*) will be used to estimate cancer risks at low dose levels. Risk will be directly related to intake at low levels of exposure. Expressed as an equation, the model for a particular exposure route is:

$$\text{Excess lifetime cancer risk} = \text{Estimated dose x carcinogenic slope factor; or CDI x } q_1^*$$

Where: CDI = Chronic daily intake

This equation is valid only for risk less than 10^{-2} (1 in 100) because of the assumption of low dose linearity. For sites where this model estimates carcinogenic risks of 10^{-2} or higher, an alternative model will be used to estimate cancer risks as shown in the following equation:

$$\text{Excess lifetime cancer risk} = 1 - \exp(-\text{CDI} \times q_1^*)$$

Where: exp = the exponential

For quantitative estimation of risk, it will be assumed that cancer risks from various exposure routes are additive. Since there are no mathematical models that adequately describe antagonism or synergism, these issues will be discussed in narrative fashion in the uncertainty analysis.

Noncarcinogenic Risk

To assess noncarcinogenic risk, estimated daily intakes will be compared with reference doses (RfD) for each chemical of concern. The potential hazard for individual chemicals will be presented as a hazard quotient (HQ). A hazard quotient for a particular chemical through a given exposure route is the ratio of the estimated daily intake and the applicable RfD, as shown in the following equation:

$$HQ = EDI/RfD$$

Where: HQ = Hazard quotient
EDI = Estimated daily intake or exposure (mg/kg-day)
RfD = Reference dose (mg/kg-day)

To account for the additivity of noncarcinogenic risk following exposure to numerous chemicals through a variety of exposure routes, a hazard index (HI), which is the sum of all the hazard quotients, will be calculated. Ratios greater than one, or unity, indicate the potential for adverse effects to occur. Ratios less than one indicate that adverse effects are unlikely. This procedure assumes that the risks from exposure to multiple chemicals are additive, an assumption that is probably valid for compounds that have the same target organ or cause the same toxic effect. In some cases when the HI exceeds unity it may be appropriate to segregate effects (as expressed by the HI) by target organ since those effects would not be additive. As previously mentioned, where information is available about the antagonism or synergism of chemical mixtures, it will be appropriately discussed in the uncertainty analysis.

5.6.1.7 Uncertainty Analysis

There is uncertainty associated with any risk assessment. The exposure modeling can produce very divergent results unless standardized assumptions are used and the possible variation in others are clearly understood. Similarly, toxicological assumptions, such as extrapolating from chronic animal studies to human populations, also introduce a great deal of uncertainty into the risk assessment. Uncertainty in a risk assessment may arise from many sources including:

- Environmental chemistry sampling and analysis.
- Misidentification or failure to be all-inclusive in chemical identification.
- Choice of models and input parameters in exposure assessment and fate and transport modeling.
- Choice of models or evaluation of toxicological data in dose-response quantification.
- Assumptions concerning exposure scenarios and population distributions.

The variation of any factor used in the calculation of the exposure concentration will have an impact on the total carcinogenic and noncarcinogenic risk. The uncertainty analysis will qualitatively discuss non-site and site-specific factors that may product uncertainty in the risk assessment. These factors may include key modeling assumptions, exposure factors, assumptions inherent in the development of toxicological end points, and spatio-temporal variance in sampling.

5.6.2 Ecological Risk Assessment

5.6.2.1 Purpose and Approach

The purpose of the proposed ecological risk assessment is to evaluate the likelihood that adverse ecological effects would occur or are occurring as a result of contamination at MCB Camp Lejeune. This evaluation will focus on identifying potential adverse effects of area-specific contamination on selected/targeted flora and fauna at each site, or group of sites (operable unit). The technical approach parallels that used in the human health risk

assessment; however, since the protocols for evaluating the ecological risk have not been sufficiently developed, the ecological risk assessment may be more qualitative than its human health counterpart. In general, the approach to be taken in the conduct of the ecological risk assessments at MCB Camp Lejeune will be comparing sampled media concentrations to existing toxicological endpoints for selected target species. In addition, incomplete exposure pathways and data gaps will be identified. If this comparison indicates the potential for significant ecological risks, the conduct of a quantitative biosurvey may be recommended as Phase II of the RI.

The primary technical guidance for the performance of the ecological risk assessment is offered by the following sources:

- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference (EPA, 1989b).

- Risk Assessment Guidance for Superfund -- Volume II, Environmental Evaluation Manual (EPA, 1989c).

- User's Manual for Ecological Risk Assessment (Oak Ridge National Laboratory, 1986).

The subsections that follow describe the general approach proposed to evaluate potential ecological impacts associated with contamination found at MCB Camp Lejeune. It focuses on environmental receptors that may be affected directly or indirectly by contamination associated with particular areas of concern, and the likelihood and extent of those effects. At each site or operable unit, potential target organisms, populations, and/or communities will be identified and the potential exposure pathways determined.

5.6.2.2 Selection of Chemicals of Potential Concern

The objective of this subtask is to evaluate the available information on contamination present at MCB Camp Lejeune, and to identify contaminants of potential concern on which to focus subsequent risk assessment efforts.

The selection of chemicals of concern will be based on frequency of detection, comparison to background concentrations, persistence of the chemical, bioaccumulation potential, and the

availability of toxicological information (to the selected target species) for those chemicals. Because of the differential toxicity of some chemicals to ecological as compared with human receptors, the chemicals of potential concern for ecological receptors may differ from those selected in the human health risk assessment.

5.6.2.3 Exposure Assessment

The objectives of the exposure assessment are to:

- Identify habitats that may have detected exposure point concentrations.
- Identify plants, fish, and/or wildlife that may be potentially exposed to the contaminants of concern.
- Identify significant pathways/routes of exposure.
- Select target species, and/or communities of potential concern.
- Estimate potential exposure concentrations for contaminants of concern.

In general, an ecological exposure assessment evaluates the potential magnitude and frequency of contact with the contaminants specific to the area through all appropriate exposure pathways for the selected species and/or communities. The first step of the exposure assessment is to identify (1) potential pathways of exposure specific to the individual areas of concern and (2) the habitats potentially affected by those areas of concern.

Pathway Identification and Habitat Evaluation

Chemical migration pathways and habitats that may be potentially affected by area-specific contamination will be identified. No modeling will be performed to evaluate the exposure assessment. Information that may be used in determining potential chemical migration pathways include:

- Location of contamination sources.
- Local topography.
- Local land use.

- Media-specific and area-specific contamination data.
- Persistence and mobility of area-specific chemicals.
- Qualitative prediction of contaminant migration.

To conduct this evaluation, the ecological exposure assessment will consist of a literature search to characterize the populations, communities, and/or habitats in the potentially affected area. The characterizations will be developed from existing reports on the ecological systems of the areas. Literature search of "reference" areas in the region also will be performed to establish an ecological "baseline" from which comparisons can be made. If the data permits, a comparison will be made between reference areas and study site areas to determine the extent to which habitat function and structure at the site may have been impaired.

The determination of which habitats warrant special attention will be based on the importance of each habitat within the environmental system, incorporating factors such as:

- Resource use by fish and wildlife.
- Probable species using these habitats.
- Availability and quality of substitute habitats.
- Importance of species using these habitats.
- Regulatory status.

Specific attention will be devoted to aquatic and terrestrial environmentals that may be impacted by site-related contamination (i.e., creeks and wetlands).

Selection of Target Species

As available from the literature, ecological exposure scenarios will be developed. These will include scenarios involving the existing and future land use of the area. Identification of the plant, fish, and wildlife species and/or communities that may be potentially exposed to contaminants will be determined for terrestrial and aquatic habitats. From this list of potential ecological receptors, target species will be based on the following criteria:

- A species that is threatened, endangered, or of special concern.

- A species that is valuable for recreational or commercial purposes.

- A species that is important to the well being of either or both of the above groups.

- A species that is critical to the structure and function of the particular ecosystem which it inhabits.

- A species that is a sensitive indicator of ecological change.

To help identify potential target species, data collected from information provided through contact with State and Federal natural resource agencies will be reviewed.

Estimation of Exposure Point Concentrations

After the potential contamination migration pathways and affected habitats have been defined and potential target receptors identified, points of likely exposure will be described. The concentrations at these contact points (i.e., exposure point concentrations) are critical in evaluating contaminant exposure and subsequent risk to the receptor.

Exposure Estimation

Exposure potential will be estimated for each terrestrial and aquatic exposure pathways from the conduct of an ecological characterization for each of the target species. This characterization will identify trophic level, habitat utilization, and potential exposure points and routes for the selected target species.

5.6.2.4 Toxicity Assessment

The toxicities of the contaminants of concern will be assessed by using AWQC and, if possible, Sediment Quality Criteria (SQC) for aquatic life, terrestrial wildlife, and vegetation where relevant. In addition, scientific literature and regulatory guidelines will be reviewed for media-specific and/or species-specific toxicity data. To the extent literature data allow, a range of toxicological responses or endpoints also will be evaluated. These data will be used to determine critical toxicity values (CTVs) for the contaminants of concern, which will be compared with media concentrations or estimated daily intakes. Toxicity values from the literature are derived using the most closely related species, where possible. Toxicity values selected for the assessment are the lowest exposure doses reported to be toxic or the highest

doses associated with no adverse effect. Data for chronic or subchronic toxicity are used wherever available.

Potential sources of toxicity data for the ecological assessment include:

- AQUIRE database
- PHYTOTOX database
- ENVIROFATE database
- Hazardous Substances Database (HSDB)
- RTECS

5.6.2.5 Risk Characterization

A risk characterization integrates the exposure and toxicity assessments to estimate the potential risk to the environmental receptors. The media concentrations or estimated daily intakes will be compared with critical toxicity values using toxicity data that are expressed in terms of medium concentrations (e.g., Ambient Water Quality Criteria, species-specific toxicity data, phytotoxicity data, sediment biological effects data). In these cases, comparing predicted environmental media exposure point concentrations with media-specific and/or species-specific toxicity data will be made. If this comparison indicates the potential for significant ecological risks to the target receptors, the conduct of a quantitative biosurvey may be recommended as Phase II of the RI.

$$HQ = C/CTV$$

Where: C = Concentration of chemical (mg/kg, mg/l).

CTV = Critical toxicity value for the same chemical in the same medium (mg/kg, mg/l).

Anything over the number one (1), indicates potential significant risks to the species.

5.6.2.6 Data Gaps

Incomplete exposure data gap pathways will be identified and recommendations for addressing same will be provided.

5.6.2.7 Uncertainty Analysis

An ecological risk assessment, like a human health risk assessment, is subject to a wide variety of uncertainties. Virtually every step in the risk assessment process involves numerous assumptions that contribute to the total uncertainty in the ultimate evaluation of risk. Assumptions are made in the exposure assessment regarding potential for exposure and exposure point locations. An effort is made to use assumptions that are conservative, yet realistic. The interpretation and application of toxicological data in the toxicity assessment is probably the greatest source of uncertainty in the ecological risk assessment. The uncertainty analysis will attempt to address the factors that affect the results of the ecological risk assessment.

5.7 Task 7 - Treatability Study/Pilot Testing

This task includes the efforts to prepare and conduct bench- or pilot-scale treatability studies. This task begins with the development of a Treatability Study Work Plan for conducting the tests and is completed upon submittal of the Final Report. The following are typical activities:

- Work plan preparation.
- Test facility and equipment procurement.
- Vendor and analytical service procurement.
- Testing.
- Sample analysis and validation.
- Evaluation of results.
- Report preparation.
- Project management.

Based on the preliminary information pertaining to Sites 6, 9, 48, and 69, the following bench or pilot studies may be considered for soils:

Site 6: Solidification/fixation of soils
Thermal treatment
Soil washing/biodegradation

Site 9: Soil washing/biodegradation
Thermal treatment
In-situ solidification/fixation
In-situ biodegradation

Site 48: Solidification/fixation

Site 69: None at this time since on-site soil investigations and soil characteristics are unknown.

Bench- or pilot-scale treatability studies for groundwater may be required to assess pretreatment options (e.g., metal reduction, etc.).

5.8 Task 8 - Remedial Investigation Report

This task is intended to cover all work efforts related to the preparation of the findings once the data have been evaluated under Tasks 5 and 6. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final RI report. Because of the complexities of the sites and the amount of information that will be generated, it is proposed that four reports will be generated. These reports will independently address the following:

- Site 6 - Storage Lots 201 and 203
- Site 9 - Fire Fighting Training Pit
- Site 48 - MCAS Mercury Dump
- Site 69 - Rifle Range Chemical Dump

This task ends when the Final RI reports are submitted.

5.9 Task 9 - Remedial Alternatives Screening

This task includes the efforts to select the alternatives to undergo full evaluation. The task begins during data evaluation when sufficient data are available to initiate the screening of potential technologies. For reporting and tracking purposes, the task is defined as complete when a final set of alternatives is chosen for detailed evaluation.

5.10 Task 10 - Remedial Alternatives Evaluation

This task involves the detailed analysis and comparison of alternatives using the following criteria:

•	Threshold Criteria:	Overall Protection of Human Health and the Environment
		Compliance With ARARs
•	Primary Balancing Criteria:	Long-Term Effectiveness and Permanence
		Reduction of Toxicity, Mobility, and Volume Through Treatment
		Short-Term Effectiveness
		Implementability
		Cost
•	Modifying Criteria:	State and EPA Acceptance
		Community Acceptance

5.11 Task 11 - Feasibility Study Report

This task involves reporting the findings of the Feasibility Study. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final FS report. Because of the complexities of the sites and the amount of information that will be generated, it is proposed that four reports will be generated. These reports will independently address the following:

- Site 6 - Lot 201 and Lot 203
- Site 9 - Fire Fighting Training Pit
- Site 48 - MCAS Mercury Dump
- Site 69 - Rifle Range Chemical Dump

This task ends when the Final FS reports are submitted.

5.12 Task 12 - Post RI/FS Support

This task involves the technical and administrative support to LANTDIV to prepare a Draft, Draft Final, and Final Responsiveness Summary, Proposed Remedial Action Plan, and Record of Decision. These reports will be prepared using EPA applicable guidance documents.

5.13 Task 13 - Meetings

This task involves providing technical support to LANTDIV during the RI/FS. It is anticipated that the following meetings will be required:

- Technical Review Committee (TRC) meeting to present the RI/FS Work Plan.
- A TRC meeting to present the findings of the RI/FS.
- Public meeting to present the proposed remedial alternatives.
- RI start-up meeting between LANTDIV and Baker.
- Meeting between Baker and LANTDIV to discuss the RI and risk assessment following submission of the preliminary draft RI report.
- Meeting between Baker and LANTDIV to discuss the FS following submission of the preliminary draft FS report.

5.14 Task 14 - Community Relations

This task involves providing support to LANTDIV during the various public meetings identified under Task 13. This support includes the preparation of fact sheets, meeting minutes, coordination with Camp Lejeune EMD in contacting local officials and media, and the procurement of a stenographer.

This task also involves updating the existing Community Relations Plan with respect to changes in personnel, contacts, phone numbers, or the addition of information relevant to this RI/FS. An addendum to the CRP will be prepared which summarizes these changes. Replacement pages to the existing CRP will be issued.

6.0 PROJECT MANAGEMENT AND STAFFING

The proposed management and staffing of this RI/FS is depicted in Figure 6-1. The primary participants for this project include:

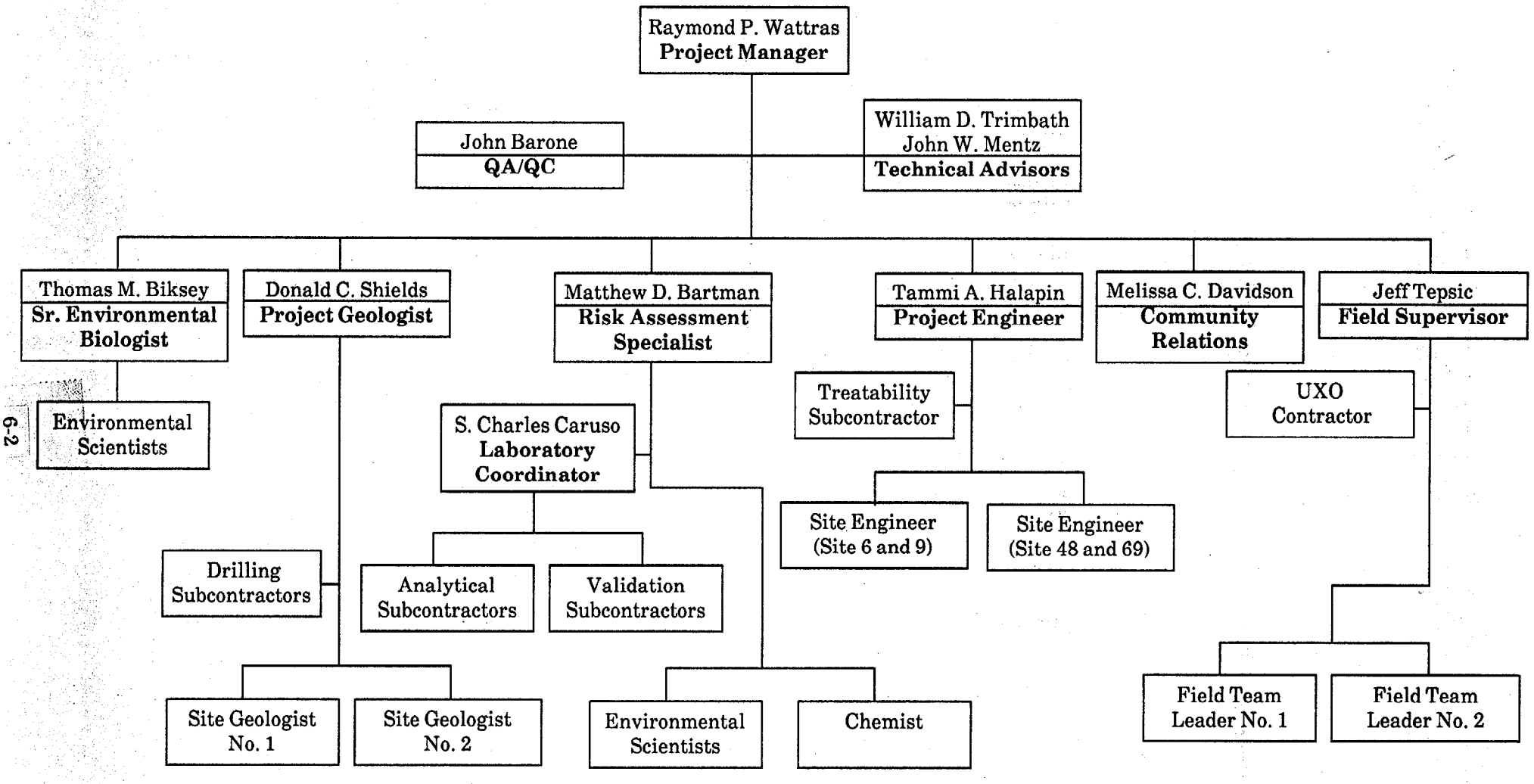
- Mr. Raymond P. Wattras, Project Manager
- Mr. John Barone, QA/QC
- Mr. Don Shields, Project Geologist
- Ms. Tammi Halapin, Project Engineer
- Mr. Matthew Bartman, Risk Assessment
- Mr. Charles Caruso, Laboratory Coordinator
- Mr. Thomas M. Biksey, Environmental Assessment
- Ms. Barbara J. Cummings, Health and Safety Officer
- Ms. Melissa C. Davidson, Community Relations Specialist

The field portion of this project will consist of two field teams. Field Team No. 1 would be assigned to undertake the investigation and reporting of Site 6 (Storage Lot 201 and Lot 203) and Site 9 (Fire Fighting Training Pit). Field Team No. 2 will be assigned to undertake the investigation at Site No. 48 (MCAS Mercury Dump) and Site 69 (Rifle Range Chemical Dump). All field activities will be coordinated by Mr. Jeff Tepsic, who will act as the field supervisor.

From a responsibility and coordination standpoint, Mr. Don Shields, Mr. Matthew Bartman and Mr. Thomas Biksey will have the overall responsibility of completing the four separate RI reports. Ms. Tammi Halapin will be responsible for overseeing the preparation of the four FS reports. These personnel will report directly to the Project Manager. They will be supported by geologists, engineers, biologists, chemists, data technicians, and clerical personnel.

Overall field and reporting QA/QC will be the responsibility of Mr. John Barone. Mr. William D. Trimbath, P.E. and Mr. John W. Mentz will provide Program-level technical and administrative support.

FIGURE 6-1
PROJECT ORGANIZATION
RI/FS AT SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA

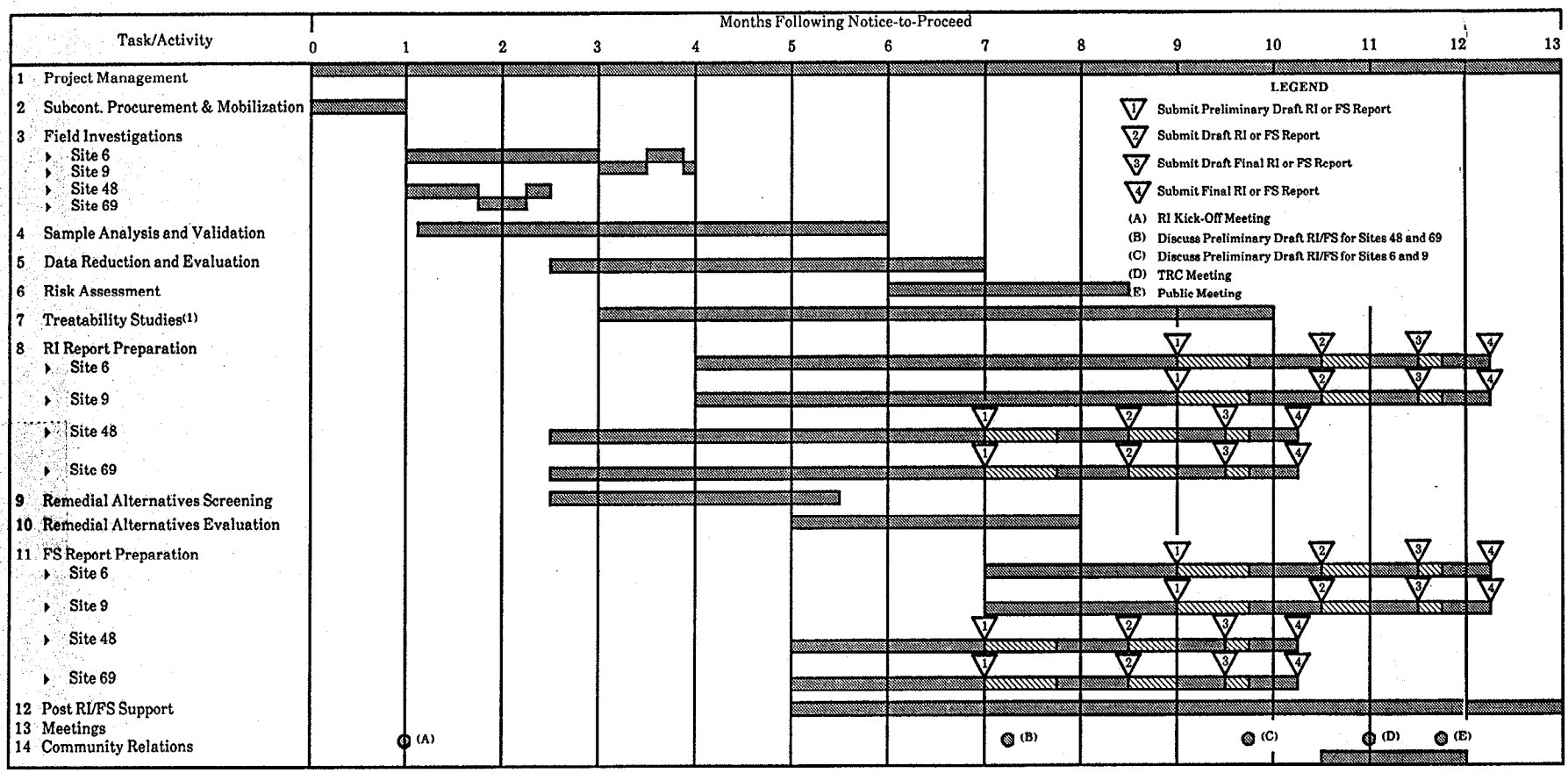


7.0 SCHEDULE

The proposed schedule for this project is presented in Figure 7-1.

FIGURE 7-1

RI/FS PROJECT SCHEDULE FOR SITES 6, 9, 48, AND 69
MCB CAMP LEJEUNE, NORTH CAROLINA



8.0 REFERENCES

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